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SECONDARY FIBER RECOVERY INCENTIVE ANALYSIS

NATIONAL ENVIRONMENTAL RESEARCH CENTER

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SECONDARY FIBER RECOVERY
INCENTIVE ANALYSIS

By

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Program Element No. 1DA312

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FOREWORD

Man and his environment must be protected from the adverse effects of pesticides, radiation, noise and other forms of pollution, and the unwise management of solid waste. Efforts to protect the environment require a focus that recognizes the interplay between the components of our physical environment--air, water, and land. The National Environmental Research Centers provide this multidisciplinary focus through programs engaged in

- studies on the effects of environmental contaminants on man and the biosphere, and
- a search for ways to prevent contamination and to recycle valuable resources.

This study comes at a time when national concern is focused on the recycling issue. Growing interest is reflected in the bills pending before Congress, statements by industry spokesmen favoring recycling subsidies, and increasing public activities at the local level. At the same time, economic considerations have prompted increased rigor in the analysis of federal spending programs. This report develops a methodology for assessing the impact of subsidies to private industry. It uses a business decision - making framework for analyzing investment decisions in terms of business strategy, organizational structure, and social context. The methodology is applied to the paper industry to provide insight into the effectiveness of selected subsidy levels.

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PREFACE

In keeping with the requirements of the Resource Recovery Act of 1970 and to obtain information for interested members of Congress, industry, and the public, the Environmental Protection Agency authorized this study in 1971 to assess the probable impacts of selected incentives for the recycling of secondary fiber within the paper industry.

This study comes at a time when national concern is directed toward the recycling issue. Significant interest is reflected in bills before Congress, statements by industry spokesmen favoring recycling subsidies, and diverse public activities at the municipal level. At the same time, economic considerations have prompted increasing rigor in the analysis of federal spending programs. The Joint Economic Committee of the U.S. Congress recently completed the first comprehensive analysis of federal subsidy programs. The Committee concluded that a large portion of the 1970 federal subsidy expenditure of more than \$50 billion was for programs whose justifications are extraordinarily vague, resounding with the "national interest" and with the "great need" for a particular activity.

The report that follows seeks to provide a cost/benefit analysis for selected recycling subsidies. It uses a business policy framework for considering investment decisions in terms of business strategy, organizational structure, and social context. The work of the Joint Economic Committee has shown that subsidies seldom efficiently achieve their desired results because they fail to adequately consider the intricacies of the systems to which they are applied. This study relies on the most recent efforts in the field of business decision-making to build a framework within which to consider recycling incentives.

The report involves original field research concerning pro forma balance sheet and income statement data for virgin and secondary based linerboard, corrugating medium, and folding boxboard manufacturing operations. Sensitivity analyses based on this data provide a mechanism for considering risks inherent in cost, price, and operating

rate fluctuations.

A major contribution of this study is illumination of the characteristics of investment decision making in large integrated businesses. We outline in depth the context of such industries and provide a base from which future researchers may consider the impact of government and business policies.

In summary, our research has relied upon recent theoretical frameworks, published consulting reports, and original field work to analyze in a systems-oriented way the recycling decision in paper and the potential impact of incentives on that decision. Our conclusion that the incentives studied are not economically justifiable despite wide political support is consistent with the rigorous evaluation the Joint Economic Committee has advised before any federal program be recommended.

ABSTRACT

Rising disposal costs and increased national concern with ecology have resulted in several Congressional proposals for subsidization of recycling. The report examines the justifications for government action and develops a framework for analysis of the paper industry and the impact of specific subsidies on the recycling decision.

Following the efforts of Alfred Chandler and Bruce Scott concerning stages of corporate structural development, and of Richard Rumelt concerning the measurable financial impacts of strategy and structure, our framework characterizes the paper industry in terms of strategic business plans and organizational structures. The study considers in depth the parameters which define the industry's vertically integrated chains of establishments: absolutely and increasingly capital intensive; commodity nature of products; capacity cycles; distribution of capital intensity; continuing pressure to integrate; primary product production rather than end product market orientation; non-extensible technology and management skills; diversification difficulty; and complex functional relationships. A major organizational problem was discovered to be the assumption of product divisional labels for segments of integrated operations. This is demonstrated to exacerbate capacity cycles and poor returns.

Pro forma balance sheet and income statement data for new virgin and secondary linerboard, corrugating medium, and folding boxboard mills show differential returns directly related to recycling rates, with secondary fiber increasingly competitive moving from linerboard to medium to boxboard. A summary of strategic, structural, and social influences highlights their importance relative to the financial impact of any of the six subsidies examined.

A benefit/cost analysis indicates that general use of any of the subsidies studied is not economically justified because of high costs per incremental ton recycled. However, support of new capital investment in specific localities may be desirable, as is continued research sponsorship to take advantage of the steep slope of the recycling learning curve. Paper firms are encouraged to consider impacts on all integrated chain segments when evaluating capital expenditures and to work at improving their interface with paperstock sources.

This report was submitted in fulfillment of Grant No. R-800-674 under the sponsorship of the U.S. Environmental Protection Agency. Work was completed in May 1974.

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SUMMARY AND CONCLUSIONS

In 1971 the consumption of fibrous materials in paper and paperboard manufacture was 55.6 million tons, while the total input of waste paper was 11 million tons. Of this, approximately 65 percent was post consumer waste (PCW) and 35 percent was prompt, or industrial waste. The overall recycling rate of 19.8 percent in 1971 represents a significant decrease from earlier times, paper being made entirely from waste rags in colonial days.

The increasing size of the solid waste stream, rising disposal costs per ton of waste, and increased national concern with ecology have generated national interest in the recycling issue. Several Congressional proposals for subsidization of recycling have recently been offered. This report examines the justifications for government action and develops a framework for analysis of the paper industry and the impacts of selected subsidies on the recycling decision.

Examination of possible government intervention in the market process is justified for the recycling issue through a demonstration of the existence of market defects which may be correctable by subsidies. These imperfections, preventing achievement of Pareto optimality, are identified as externalities, imperfect information, and lack of factor mobility. Only a cost/benefit analysis, however, can justify specific government intervention to deal with the above market defects.

The paper industry is characterized from historical and technological perspectives in Chapter III and related appendices. Current production of paper and board reflects the two major areas of industry development: ability to utilize more fiber types and advances in forming machine technology. Improvements in both areas were slow to come into general use after initial experimentation proved their feasibility. Once in use, incremental process improvements increased versatility and efficiency. Both lines of technological development have eroded the market share held by waste paper. New pulping methods allowing the use of more roundwood and wood residue fiber types have increased the alternatives available and opened very cheap fiber sources. More efficient virgin fiber forming machine technology and years of incremental improvements provide formidable cost competition.

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Chapter IV introduces the framework for analysis of the context of investment decisions in the paper industry. Following the efforts of Alfred Chandler and Bruce Scott concerning stages of corporate structural development, and of Richard Rumeit concerning the measurable financial impacts of strategy and structure, this framework characterizes the paper industry in terms of strategic business plans and organizational structures. The study considers in depth the parameters which define the industry's vertically integrated chains of establishments: absolutely and increasingly capital intensive; commodity nature of products; capacity cycles; distribution of capital intensity; continuing pressure to integrate; primary product production rather than end product market orientation; non-extensible technology and management skills; diversification difficulty; and complex functional relationships. These factors result in a heavy emphasis on primary product production with its high volume efficiency and the critical importance of guaranteeing input (supply) and output (sales) quantity, quality and price. The comparative disadvantages of post consumer waste fiber relative to these criteria argue that incentives would have to be very large to have a meaningful impact on the recycling decision.

Pro forma balance sheet and income statement data for new virgin and secondary linerboard, corrugating medium, and folding boxboard mills are presented in Chapter V. The several return measures calculated show differential pro forma returns directly related to recycling rates with secondary fiber increasingly competitive moving from linerboard to medium to boxboard. However, only in boxboard is post consumer waste competitive with virgin fiber.

Chapter VI describes the strategic, structural and social contexts of the firms studied in depth as those contexts relate to the investment decision. A major problem discovered was the assumption of product divisional labels for segments of vertically integrated operations. Many paper firms followed fashion rather than necessity in moving to nominally divisionalized organizational structures. This is demonstrated to exacerbate capacity cycles and poor returns as a result of failure to consider explicitly the total impact of investment in one segment of the integrated chain.

The financial and contextual impacts of six possible recycling subsidies are examined in Chapter VII. The

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milieu so that production costs are lowered for all firms. The case at issue is not one where costs to the purchasing industry become lower because factors are sold more cheaply to it as its output increases; in other words, we bypass the argument of pecuniary increasing returns to industry scale. The focus is on the nonpecuniary benefits that arise because the growth of the industry makes a better environment for production; it may, for example, indirectly induce a higher level of education in the community.

In such a case, as the industry grows larger, each firm's costs become lower for any given output per firm. Yet since no one firm is large enough to expand the industry appreciably by itself, and no one old firm can expand without running into increasing costs, the lowering of cost does not occur until an external stimulus is given, as by a subsidy. As all firms react to a subsidy by expanding output, each firm finds that, while price falls owing to the additional product put on the market by the industry as a whole, the firm's cost also falls. This fall in cost represents an increase in real economic welfare that has traditionally been used by economists, particularly in the field of transportation, as a justification for a subsidy.³⁴

It may be argued that each of these market defects offers a theoretical justification for examining the desirability of government intervention via subsidies into the paper recycling issue. Externalities are important because producers and consumers of specific paper products which join the solid waste stream do not bear all the costs of collection, disposal, and pollution (air, water, noise, aesthetic). We may assume the existence of non-internalized externalities because of the obvious transaction cost and difficulty (imagine each party near a dump or collection route bargaining with each producer of solid waste to reduce or alter the character of his production). A recycling operation provides external benefits by lowering collection, disposal, and environmental (virgin preservation, production pollution, waste stream pollution) costs for municipalities and by promoting a new consciousness concerning the

circularity of material flows. Without recycling of waste paper, 11 million additional tons would have been added to, or remained in, the solid waste stream for disposal in 1971.³⁵ In addition to saving collection and disposal costs, recycling allowed approximately 20 million tons of wood to remain unharvested.³⁶ Imperfect information concerning the true cost of virgin resources, waste paper technology, and alternative waste paper supply sources reduces the efficiency of the market mechanism where recycling is concerned. Lack of factor mobility in terms of decision-making attitudes toward post consumer waste and its sources hampers new recycling efforts. As Adam Smith observed, "...Man is of all forms of luggage the most difficult to be transported".³⁷ Decreasing industry costs might be used as an argument to expand and stabilize the supply of secondary fiber through federal action, since a relatively small floating supply and fluctuating prices now hinder waste usage.

Appendix II discusses and analyzes at length the characteristics of Federal subsidy programs, both generically and through evaluation of specific programs.

Present Subsidies Related to Recycling

The federal tax subsidy to the timber industry entails three aspects: (1) capital gains treatment of increases in timber value; (2) deduction of timber maintenance costs against current income; and (3) conversion of ordinary income into capital gains through expense deductions against income from lumber or pulp sales.³⁸ The capital gains treatment alone reduces Federal revenue by \$130 to \$140 million per year, or about one-fourth of direct Federal expenditures for timber programs.³⁹ Because of the tax nature of the subsidy, it favors large corporations and high income individuals, while the "most deplorable" forestry conditions exist on farms and small private ownerships.⁴⁰ Tax data indicate that large, integrated corporations with significant amounts of income from logging, lumber, plywood, pulp, and various paper products are able to shift nearly all their income into the lightly taxed capital gains category.⁴¹ The value of the subsidy is estimated at \$.68 per ton of pulpwood, which is about .4 percent of the value of bleached kraft pulp at \$170 per ton.⁴² However, for International Paper's 12.284 million tons of paper and board produced

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analysis illustrates that only the larger incentives have a potentially meaningful impact. Strategic, structural, and social influences are discovered to be more significant in the investment decision than a mere comparison of financially stated returns. The organizational interface between the typical large paper firm and paperstock sources is shown to be a significant barrier to recycling.

Implications for government and business policy are presented in Chapter VIII. A benefit/cost analysis indicates that general use of any of the subsidies studied is not justified because of very high costs per incremental ton recycled. However, support of new capital investment in specific localities may be desirable, as is continued research sponsorship to take advantage of the steep slope of the recycling learning curve.

The study concludes that any federal action designed to take industry context specifically into account will be more effective. This implies the desirability of continued GSA purchasing subsidies and of mechanisms to improve the paperstock source/paper firm interface. One important implication of our research for business policy concerns the potentially unstable situation within an integrated chain of activities in which functional relationships are not recognized explicitly because of product divisional labels. It is recommended that planning for change in any chain segment account for later impacts on all other chain elements. Another implication for the paper industry concerns the lowered concentration and increased competition expected if recycling becomes economically more attractive. The largest paper firms experience difficulty at the social and organizational interface with paperstock sources and municipalities, while smaller companies may work effectively with PCW recycling. Thus, we may anticipate lowered concentration ratios to accompany major recycling increases, unless major firms alter their structural and social contexts.

CHAPTER I: INTRODUCTION TO THE PROBLEM

The United States paper industry has moved increasingly from secondary materials toward new wood-based pulps. In 1971 the consumption of fibrous materials in paper and paperboard was 55.6 million tons,¹ while the total input of waste paper was 11 million tons.² Of this, approximately 65 percent³ was post consumer waste (PCW) and 35 percent was prompt, or industrial waste. The resulting overall waste paper recycling rate of 19.8 percent⁴ represents a significant decrease from colonial times when paper was made entirely from waste rags.

The recent increased national concern with ecology and the efficient use of resources has coincided with rising difficulty in disposing of solid wastes in an environmentally acceptable and financially feasible manner. Legislation bearing on air and water pollution connected with waste disposal has driven landfill disposal costs \$4-8 per ton and incineration costs to \$10-15 per ton.⁵ When added to collection costs of \$15-30 per ton, the magnitude of the solid waste problem becomes clear.⁶

Increased solid waste costs and national interest in recycling have prompted the introduction of several bills in Congress which would subsidize recycling. A subsidy for recycling could provide three major benefits: displacement of virgin raw materials; reduction of municipal solid waste costs; and the promotion of a new consciousness concerning the circularity of material flows and the preservation of resources.

Objective

The objective of this paper is to develop a framework which may be used in assessing the impact of selected incentives on the decision to recycle in the paper industry. For the purposes of this study, the recycling decision is the commitment of resources to new capacity based principally on secondary input sources.⁷ Our framework operates on two levels: a conceptual scheme for categorizing and analyzing industry data and an

income statement model for computing the financial impact of selected subsidies. The data base and its organization shed new light on the industry and should prove useful to later researchers. Our income statement model, allowing calculation of return on investment for various industry sub-sectors under different assumptions, provides a means of evaluating projects in terms of financial investment decision criteria.

Literature on the capital investment process highlights the difficulty of employing a simple framework to adequately characterize investment decision making. Bower found structural context and the social system important in the investment process.⁸ Ackerman added diversity and divisional interdependence as meaningful variables in the decision making process.⁹

With these complexities noted, and the Bower and Ackerman works as background, we shall attempt to characterize in a conceptual way the investment process in the paper industry as it bears on recycling. The most straightforward part of the study revolves around analysis of process cost, income and investment parameters with recycling vs. virgin material use, the impact of incentives on these items, and the financial decision criteria used in the industry. Clearly, this portion of our framework would not be sufficient to adequately understand the recycling decision. Thus, the information set includes historical industry data to help us gain an understanding of capacity cycles,¹⁰ industry product-market strategy, and supply source trends. Field research places data in strategic, structural (organizational), and social contexts.

The study attempts to build an in-depth understanding, or "feel," for the industry and the importance of various parameters in its decision making process.¹¹ It endeavors to maintain interest by interspersing statistics and field research in a varied manner. Thus, a specific topic area may be referred to in several chapters as research findings are developed.

Hypotheses Under Investigation

The hypotheses under investigation are:

1. Selected incentives will have a significant impact on the decision to build a new mill.
2. Government intervention in the "market" process is economically justified for the recycling issue. (Elaboration of the term "justified" is contained in Chapter II.)

Research Methodology

The research methodology involves:

1. Literature search concerning:
 - a. justifications for subsidies;
 - b. existing subsidy forms; and
 - c. new subsidy proposals.
2. Historical and technological characterization of the industry from published sources.
3. Description of industry strategy using Bureau of the Census and industry association data within a business policy strategy framework.
4. Description of organizational and social contexts from field research with at least two firms in each sub-industry: linerboard, corrugating medium, folding boxboard, and tissue.
5. Derivation of pro forma economics from literature search and field research in selected sub-industries.
6. Development of a simple computer income statement model to allow analysis of sub-industry data showing financial impacts of selected subsidies.

The field research owes a major debt to Ackerman,¹² whose extensive field work in the paper industry made this author's effort much easier and more productive. The contextual framework within which our results are presented is a valued heritage of Chandler,¹³ Bower,¹⁴ Rumelt,¹⁵ Scott,¹⁶ and Ackerman.¹⁷

The study uses government statistical data sources where possible, rather than industry association data. While this broadens the data base, lends credibility, and conforms to research requirements, it introduces complexity in understanding the paper industry. Federal Trade Commission, Bureau of the Census, and Internal Revenue Service data differ substantially. These differences are exaggerated by changes in categories, allocation of products to categories, and misleading nomenclature. There being no way to avoid these inconsistencies if a meaningful understanding of the industry is to be developed, the reader is advised to make liberal use of the general and detailed SIC descriptions in Appendices I and IV.

Chapter Overview

Chapter II presents a literature review of the justifications for examining government intervention via subsidies, a summary of subsidies affecting recycling, and an outline of current subsidy proposals.

Chapter III characterizes the paper industry from historical and technological viewpoints, tracing developments in both virgin and secondary fiber use. It highlights the gradual erosion of waste paper's market share as technological developments allowed chemical pulping to utilize an increasing number of roundwood and wood residue fiber types. And it points out the industry's relative slowness to adopt new technology.

Chapter IV introduces the conceptual framework within which the new mill decision is analyzed. It outlines the strategic and organizational parameters that define a vertically integrated chain of establishments. In this chapter the importance of context is outlined in its broad form, and the results of field research anticipated in presenting a "feel" for the industry.

Chapter V discusses the four industry sub-sectors selected for in-depth study, explaining that they cover a wide range of processes, economies of scale, and market interactions. It presents pro forma process (as opposed to statistical) cost, balance sheet, and income statement data for new virgin and secondary fiber-based

linerboard, medium, and folding boxboard mills. The chapter characterizes differences among the segments, within the context of Chapter IV. We find that differential pro forma returns are directly related to recycling rates with secondary fiber increasingly competitive with virgin as we move from linerboard to medium to boxboard. However, only in boxboard is secondary fiber fully competitive with virgin in terms of future use.

Chapter VI describes the decision context of the individual firms studied in depth. In the first section, the strategy and structure of each firm is outlined. The second section discusses the new mill investment process, noting capacity discrepancies and investment return hurdle rates. The third section deals with specific differences in the investment process for a recycling mill.

Chapter VII analyzes the financial and contextual impacts of six recycling subsidies:

1. 5-year depreciable lives for plant and equipment;
2. \$10/ton to secondary input;
3. \$20/ton to secondary input;
4. 18 percent of secondary input purchase cost;¹⁸
5. 50 percent of secondary input purchase cost;
and
6. 20 percent investment tax credit for recycle plant and equipment.

The data illustrate that the larger incentives have a potentially meaningful, but not overwhelming, financial impact only for corrugating medium and higher caliper boxboard. A summary of strategic, structural, and social contextual influences on the recycling decision highlights their importance relative to income statement comparisons.

Chapter VIII presents implications for government and business policy and for further research. Through a rough cost/benefit analysis we conclude that subsidy costs per incremental recycled ton are too high to

justify general use of any of the subsidies analyzed. However, support of new capital investment for recycling in specific geographical areas with high collection, disposal, and pollution control costs may be desirable. The steeper slope of the recycling learning curve relative to virgin argues strongly for continued demonstration grant and research support. The study notes that any federal action designed to take industry context specifically into account will be more effective. This implies the desirability of continued GSA purchasing subsidies and of mechanisms to improve the paperstock source/paper firm interface. One important implication of our research for business policy concerns the potentially unstable situation within an integral chain of activities in which functional relationships are not recognized explicitly because of product divisional labels. This is shown to aggravate capacity cycles and lower overall returns. We recommend that planning for change in any chain segment account for later impacts on all other chain elements. Another implication for the paper industry concerns the lowered concentration and increased competition expected if recycling becomes economically more attractive. The largest paper firms experience difficulty at the social and organizational interface with paperstock sources and municipalities, while smaller companies may work effectively with PCW recycling. Thus, we may anticipate lowered concentration ratios to accompany major recycling increases, unless major firms alter their structural and social contexts.

CHAPTER II: RATIONALE FOR A RECYCLING SUBSIDY

The gross budgetary cost of federal tax and cash subsidies in 1970 amounted to \$50,281,000,000.¹ The arguments for many of these programs are extraordinarily vague, resounding with the "national interest", "national defense", and with the "great need" for a particular activity.² We hope to address the topic more rigorously. The chapter presents a theoretical economic basis for examining the possibility of federal intervention in the recycling issue; a catalog of present subsidies related to recycling; and a discussion of current legislative proposals.

Theoretical

"An allocative mechanism may be deemed desirable if it leads to Pareto optimal allocation of resources."³ Under the Pareto optimality efficiency criterion it is impossible to better one societal unit's "condition" without worsening another's, via reallocation.⁴ "Condition" might be defined as utility or amount of goods and services.⁵ It is a fundamental theorem of economics,⁶ and presumably of our society, that, given certain assumptions about market mechanism efficiency (information, technology, competition, etc.), producers, and consumers, there exists a set of market prices which will produce Pareto optimality for an economic system. Economists have not been able to agree on the minimum set of assumptions necessary for markets to attain Pareto optimality,⁷ but we may assert that the failure of the market mechanism to perform its job perfectly is well recognized.⁸ Correction of the defects responsible "is an objective of public economic policy, and in some cases an appropriate objective for subsidies."⁹

Monopolistic power and the provision of pure public goods are illustrative of cases where the market mechanism has failed to promote optimality.¹⁰ Theoretically, per unit subsidies could be paid to the monopolist to induce expansion of output;¹¹ however, the government has attempted to deal with monopoly through antitrust laws or the public utility concept.¹² The market mechanism

is unable to price and efficiently provide pure public goods because of the "non-excludability of other units of the economy from enjoying the product once it is being provided to any one unit"¹³ (this may also be thought of in terms of the broad problem of transaction costs as noted by Guido Calabresi¹⁴).

A perspective on the issue is given by Professor Calabresi who states "as an axiom the proposition that all externalities (to be defined infra) can be internalized and all misallocations...can be remedied by the market, except to the extent that transactions¹⁵ cost money or the structure itself creates some impediments to bargaining". Under the structure heading we might include such issues as the following: monopoly power; imperfect information concerning prices, markets, technology or risk; and lack of factor mobility from technological, human, or organizational patterns. Externalities are a major issue in welfare economics and deserve elaboration.

The topic of externalities deals with "divergences between social and private net products"¹⁷ arising because, to quote A.C. Figou:

One person A, in the course of rendering some service, for which payment is made to a second person B, incidentally also renders services or disservices to other persons (not producers of like services), of such a sort that payment cannot be exacted from the benefitted parties or compensation enforced in behalf of the injured parties.¹⁸

Ralph Turvey¹⁹ points out in an excellent analysis of Coase's "The Problem of Social Cost", Davis and Whinston's "Externalities, Welfare and the Theory of Games", and Buchanan and Stubblebine's²² "Externality" the oversimplicity of the notion that externality effects can be dealt with by a tax or a subsidy equal to the difference between marginal social and private costs. Turvey proves that where A and C, the affected party, are able to negotiate (reasonable transaction costs), a tax on A for external diseconomies will not result in Pareto optimality unless it is paid to C.²³ This applies also to subsidies since a subsidy scheme may be designed, in theory, to achieve the same

results as a tax scheme.²⁴

Tuvey presents an illustration of externality economics which we shall repeat here with only minor modifications.²⁵ Figure II-1 shows the case diagrammatically. It is assumed that A has only two activities: I, the production of paper from virgin fiber; and II, the production of paper from secondary fiber. The vertical axis is dollars of gain for A or loss for C, the recipient(s) of the external diseconomy. A's total gain is the area under his marginal gain curve. C's total loss, after making the best possible adjustment to A's activities, is the area under his curve.

With no restriction on A and without the ability to negotiate with C, A would produce virgin paper to a scale of OV. Production at OS would yield a larger social product, but the optimum is recycling at OJ since area 2 is greater than area 1. C would pay up to $(1a+1c-2a)$ to achieve this result, while A would accept down to $(1+1a-2-2a)$. Thus, there is a positive maximum gain to be shared between them, $(1c-1+2)$. It is the goal of realization of this gain which prompts consideration of government action. With no negotiation and perfect knowledge of A and C's curves, a tax or subsidy could be applied to A to generate the dotted curve on the right, A's new marginal gain function.

The conclusion of the above example is not necessarily that government intervention is justified or desirable. Turvey states:

When negotiation is possible, the case for government intervention is one of justice not economic efficiency; when it is not, the theorist should be silent and call in the applied economist.²⁶

Calabresi states:

The primary implication is that problems of misallocation of resources and externalities are not theoretical but empirical ones.²⁷

The issue becomes one of whether or not the state "can ascertain and enforce a move to the optimum position at a cost less than the gain to be had, and if it can do

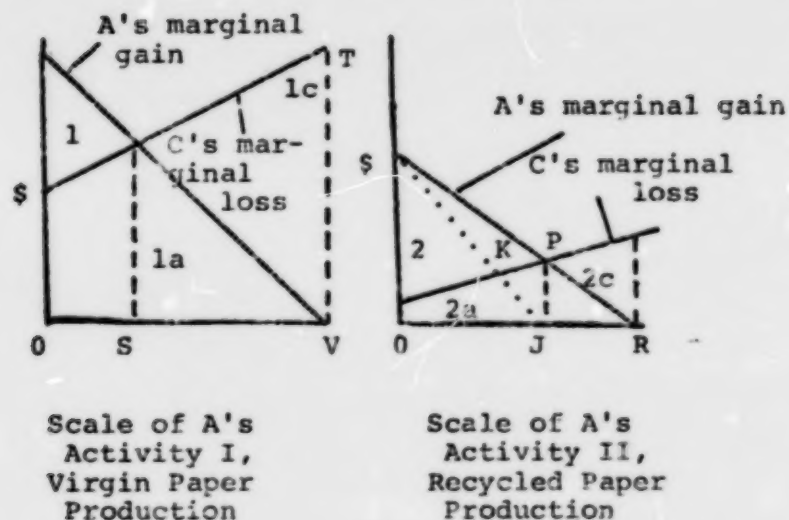


Figure II-1. An Illustration of Externalities. Source: Adapted from Ralph Turvey, "On Divergences between Social Cost and Private Cost" in Dorfman and Dorfman, editors, Economics of the Environment, (New York: W.W. Norton and Co., Inc., 1972) p. 132.

this in a way that does not have unfavorable effects" on other parameters.²⁸ In our example, the state would have to estimate all curves in the diagram by evaluating all the alternatives open to A, their impacts on C, and C's potential adjustments.²⁹ Where the nature as well as scale of activities is variable, as is customary, examination and control is extremely complex. Relative costs and risks of the variety of possible state intervention strategies (subsidies, taxes, structural and liability rules, etc.) are pieces in the empirical problem long after the theoretical case for examining state action is closed.

We are left with the requirement for comprehensive cost/benefit analysis, at the margin and overall,³⁰ before the economist can justify a state action to improve resource allocation. Calabresi³¹ makes two important points in this regard. The first is that since transactions or their state substitutes do involve costs, the "optimal" result is not necessarily that of an assumed costless transaction environment, and economists must be careful not to play meaningless games. Secondly, both the "optimal" goal and the gains along the way are not usually definable or quantifiable. This implies the importance of guesses and the difficulty of empirical proof of the benefits from proposed state action.³² If this discussion has appeared discouraging to those hoping for some clear-cut answers, it is appropriate.

We should note before leaving this section that the Joint Economic Committee of the U.S. Congress published in 1972 what it stated to be the first "comprehensive development of the basic economics of subsidies".³³ The Committee concluded that subsidies were theoretically justifiable (leaving the actual desirability of federal action to detailed empirical cost/benefits analysis) for dealing with the following market defects: i) externalities; ii) imperfect information; iii) lack of mobility; and iv) decreasing cost industries. Only the latter is unfamiliar, although its elements have been discussed, and we reproduce the Committee's explanation:

The cost conditions for an entire industry may be such that if all firms expand together (and new firms enter), the increased output brings with it a sufficiently more favorable

in 1972, excluding building materials, this amounts to \$8.35 million, or about 8 percent of net revenue that year. There is insufficient evidence to indicate the extent to which the timber tax subsidy is responsible for increases in forest planting and management since its enactment in 1943⁴³ because of concomitant developments in housing demand, disappearance of old-growth timber supplies, and stumpage price increases.⁴⁴

Transportation rates are another issue related to recycling. Transportation subsidies hinder recycling, according to the National Association of Secondary Materials Industries (NASMI):

A significant cost factor in the recovery and utilization of recycled materials is that related to transporting the material to its natural and most economical market. Through the past years, the transportation rates established by the nation's railroads and Steamship Conferences and companies have discriminated against recycled materials as compared to their virgin counterparts...

In short, transportation rates and policies have not been adequately related to recycling objectives that have been pronounced by the Federal Government as essential to the economic and environmental goals of the nation.⁴⁵

Transportation analyses which have been conducted have not fully resolved the question of whether or not rates are discriminatory between virgin and secondary materials.⁴⁶ A major problem in such analyses is the technical difficulty of profit comparison.⁴⁷ The cost factors which are used of the ICC in rate setting involve the following: ⁴⁸

- . Density and compactness loading;
- . Perishability;
- . Susceptibility to damage;
- . Liability of spontaneous combustion or explosion;
- . Volume of movement and influence of volume on direct costs;
- . Value of commodity;
- . Regularity of movement;
- . Ease of loading and unloading;

- . Type of equipment required;
- . Special resources required;
- . Stowability;
- . Excess weight and excess length.

Thus, the analysis to document the nature of internal regulatory subsidies, if any, within ICC-set rates is a major task beyond the scope of this study. The matter is further complicated by in-practice negotiation of rates using ICC rates as upper bounds.

The IRS introduced another subsidy by ruling in June, 1972, that solid waste recycling facilities are eligible for financing by municipal-industrial revenue bonds providing 65% of raw materials input was reclaimed from solid waste.

Another form of subsidy is the General Services Administration (GSA) specification of secondary material content for some paper products it purchases. Required percentages of post consumer and prompt waste are set for 77 of 144 paper product categories purchased by the GSA.⁴⁹ In 1972, these 77 product categories accounted for \$57 million of the \$88 million total GSA paper purchases.⁵⁰

The Resource Recovery Act of 1970 extended the Solid Waste Disposal Act of 1965 for another three years. Amendments expanded research and demonstration grants concerning recycling and created a National Commission on Materials Policy.

Proposed Subsidies for Recycling

The Moss Bill is the most comprehensive of pending legislation.⁵¹ The Bill's goals are: "to promote and enhance interstate and foreign commerce in recyclable and recycled materials; to encourage the utilization of reclaimable post consumer waste materials, and to encourage conservation of our previous energy reserves and natural resources through effective recycling." The bill contains the following major provisions relating to paper recycling:

201. ICC should eliminate rate discrimination.
202. Federal government agencies should be required to purchase materials with a

minimum percentage of secondary input, to be defined by the EPA.

203. An extra deduction from taxable income of 18 percent of the cost of secondary fiber input, if purchase costs exceed the average yearly costs incurred by the taxpayer for similar purchase during the previous 5-year period. An additional 9 percent of purchase cost deduction to be allowed if the tax savings from the 9 percent deduction are used wholly for the expansion of recycling facilities, expanded utilization of recyclable facilities, expanded utilization of recyclable or recycled solid waste materials, or pollution control devices.
204. Election, if desired, to amortize any recycling plant or equipment over a 60-month period.
301. An energy consumption deduction not to exceed 50 percent of the input material cost. Deduction shall be computed as follows:
 - (a) determining the total energy costs in extracting, refining, transporting, and otherwise producing the material from virgin resources.
 - (b) determining the total energy consumed in collecting, separating, transporting, and otherwise producing comparable material from recyclable materials.
 - (c) subtracting (b) from (a). In the event (b) is larger than (a), the energy consumption adjustment shall be computed by subtracting (a) from (b) and subtracting the result from the deduction allowed for the purchase of that recycled material.
401. It shall be unlawful for any person to introduce or deliver for introduction into interstate commerce of the United States any manu-

factured product or container or package for which the Administrator has prescribed product standards pursuant to section 402 of this title and which does not conform to such standards prescribed by the Administrator.

402. (a) Within one year from the enactment of this title, the Administrator shall promulgate such standards regulating the manufacture, distribution, reuse, and recycling of products, containers, or packages in commerce as are necessary to protect against unreasonable burdens on commerce and risks to health or environment associated with the disposal of such products. Such standards shall include minimum percentages of recyclable materials which shall be contained in such products, containers, and packages, maximum permissible quantities of component materials which produce adverse environmental effects when such products, containers, or packages are discarded, and may prescribe methods of distribution for certain products and containers and prohibitions against the manufacture and sale of specific products and containers.
407. Loan program to state and local governments for solid waste systems that encourage recycling, with repayment reductions based upon performance.

Mr. Minshall's bill⁵² would allow a 20 percent investment tax credit (I.T.C.) for solid waste processing equipment. This tax credit would be in addition to allowing 5-year amortization, but not in addition to any other I.T.C.

Mr. Burke's legislation⁵³ would offer a \$10/ton tax credit against PCW processed into pulp, paper, board, or similar products.

Senator Hart, for himself, Senator Moss, and Senator Proxmire, introduced a bill⁵⁴ in May, 1973 to reduce solid waste and stimulate recycling. Its major provisions would: eliminate discriminatory transportation rates; involve product standards set by EPA; set charges for products with less than 30 years life which enter the solid waste stream; and provide payments equalling disposal costs to users of secondary materials.

The Boxboard Research and Development Association (BRDA), the National Association of Secondary Materials Industries (NASMI), and various industry spokesmen⁵⁵ have advocated tax subsidies for PCW based on a percentage of purchase cost. They range from an 18 percent tax credit to a 50 percent extra deduction from taxable income.

The American Paper Institute has proposed a tax credit of a fixed (but yet to be determined) dollar amount per ton of post consumer waste secondary fiber input to a production process.⁵⁶ Their proposal is significant in two notable areas: restriction of the subsidy to post consumer waste and non-variability with input price of the secondary fiber. Post consumer waste (PCW) may be defined as follows:

Any product that has gone through its useful life, served the purpose for which it was intended, and is discarded by the user. Waste or scrap created in a manufacturing or converting operation is not considered post-consumer waste. However, post-consumer waste is generated in homes, commercial establishments, industrial plants, institutions, government offices and the like.⁵⁷

Both these provisions were designed to direct the subsidy to fibers least likely to be recycled now. Almost all prompt waste (product waste resulting from a product's production) is currently recycled. A fixed dollar amount would favor low priced fiber which is now less used, on a percentage basis. Regarding the tax nature of the desired subsidy, the American Paper Institute stated:

A tax credit is preferred largely because it is the least complex to calculate. Also, it has the advantage of becoming a more permanent part of the Internal Revenue Code and therefore, can be relied upon in long range planning in contrast to any type of cash incentive that might have to be included in the budget and voted by Congress each year.⁵⁸

However, the American Paper Institute (API) believes that "government should not try to increase recycling

through disincentives such as special taxes or through executive fiat either of which can only result in impractical, ineffective and uneconomical compliance systems and procedures.⁵⁹ The hoped-for effect of the subsidy is based on a Midwest Research Institute report for the American Paper Institute:

External forces providing incentives and new demand for recycled products would reverse the current trends in resource/use patterns and lead to a recycling rate of 26 percent by 1985 compared to under 21 percent in 1970 In the absence of external forces on the industry 17 percent of paper and paperboard consumption would be recycled in 1985....⁶⁰

It is one purpose of this paper to examine the impact of some of these subsidy proposals.

CHAPTER III: HISTORICAL AND TECHNOLOGICAL CHARACTERIZATION OF THE PAPER INDUSTRY

This chapter presents a very brief historical and technological overview of the paper industry. Appendix III, written in chapter format, provides a much more thorough treatment.

The Early American paper industry, using secondary fiber (mostly rags) for 100% of its input, was plagued by a shortage of these fibers, as well as by bad quality paper. Only after the Civil War did the industry expand rapidly, due essentially to access to new sources of fiber (from wood) and the development of new papermaking technology. Table III-1 illustrates 1971 U.S. production of paper and board.

Current production reflects the two major areas of industry development: ability to use more fiber types and efficiency in forming machine technology. Improvements in both areas were slow to come into general use after initial experimentation proved them feasible. Once in use, incremental process improvement expanded their efficiency and versatility. In the case of fiber suitability, mechanical pulping gave way to chemical methods which could accept soft wood fibers, which, unlike rags or waste paper, were not easily mechanically pulpable. The development of the Kraft chemical process allowed pulping of both hard and soft woods to produce a stronger product while using efficient and environment-saving recovery of pulping chemicals. More than 66% of virgin wood pulp in 1971 was kraft, and the percentage is rising.¹ The use of the kraft process and its expansion to wood residues is reflected in Table III-2. Development of the Fourdrinier paper machine allowed mechanical formation of the paper sheet and led to increasing economies of scale. The Fourdrinier remains essentially the same in design today as 170 years ago.

A comparison of process flows between virgin and secondary fiber is made in Figure III-1. It is apparent that the major differences are in the pulping stage. There are four key technological factors behind the pattern of waste paper use: a) heterogeneity of waste

Table III-1. 1971 U.S. PRODUCTION OF PAPER AND BOARD^a

Grades	Production, 000's tons
All Grades	55,092
Paper	23,838
Printing, writing, and related	14,505
Packaging & Industrial Con- verting	5,458
Tissue	3,876
Paperboard	26,121
Virgin unbleached linerboard	11,312
Virgin bleached packaging	3,501
Virgin corrugating medium	3,717
Recycle shipping board	1,391
Recycle boxboard	3,635
Other	2,547
Construction Paper and Board	4,995

^aSource: U.S. Department of Commerce, Bureau of the Census, "Current Industrial Reports." Please see Appendix IV for a full breakdown. Figures may not add due to rounding.

Table III-2. FIBROUS MATERIALS CONSUMED IN U.S. PAPER AND BOARD MANUFACTURE^a

Year	Wood pulp (percent)					Waste paper (percent)	Rags and other (percent)	Total (percent)
	Total wood pulp	Roundwood		Residues				
		Softwood	Hardwood					
1950	63.7	52.8	8.3	2.6	30.7	5.6	100	
1971 (P)	78.5	40.0	14.9	23.6	19.8	1.7	100	

^aSource: 1950: Total wood pulp, waste paper, rags and other percentages calculated from census data by the American Paper Institute. Percentages within wood pulp are calculated by author based on cordage from statistics on domestic wood pulp production from the U.S. Department of Agriculture, Forest Service, "The Demand and Price Situation for Forest Products 1971-1972." Miscellaneous Publ. No. 1231. (July, 1972). p. 74.

^b1971 Preliminary: Total wood pulp, waste paper, rags and other calculated by author based on Bureau of the Census, Current Industrial Reports Series M26A(13), 1972.

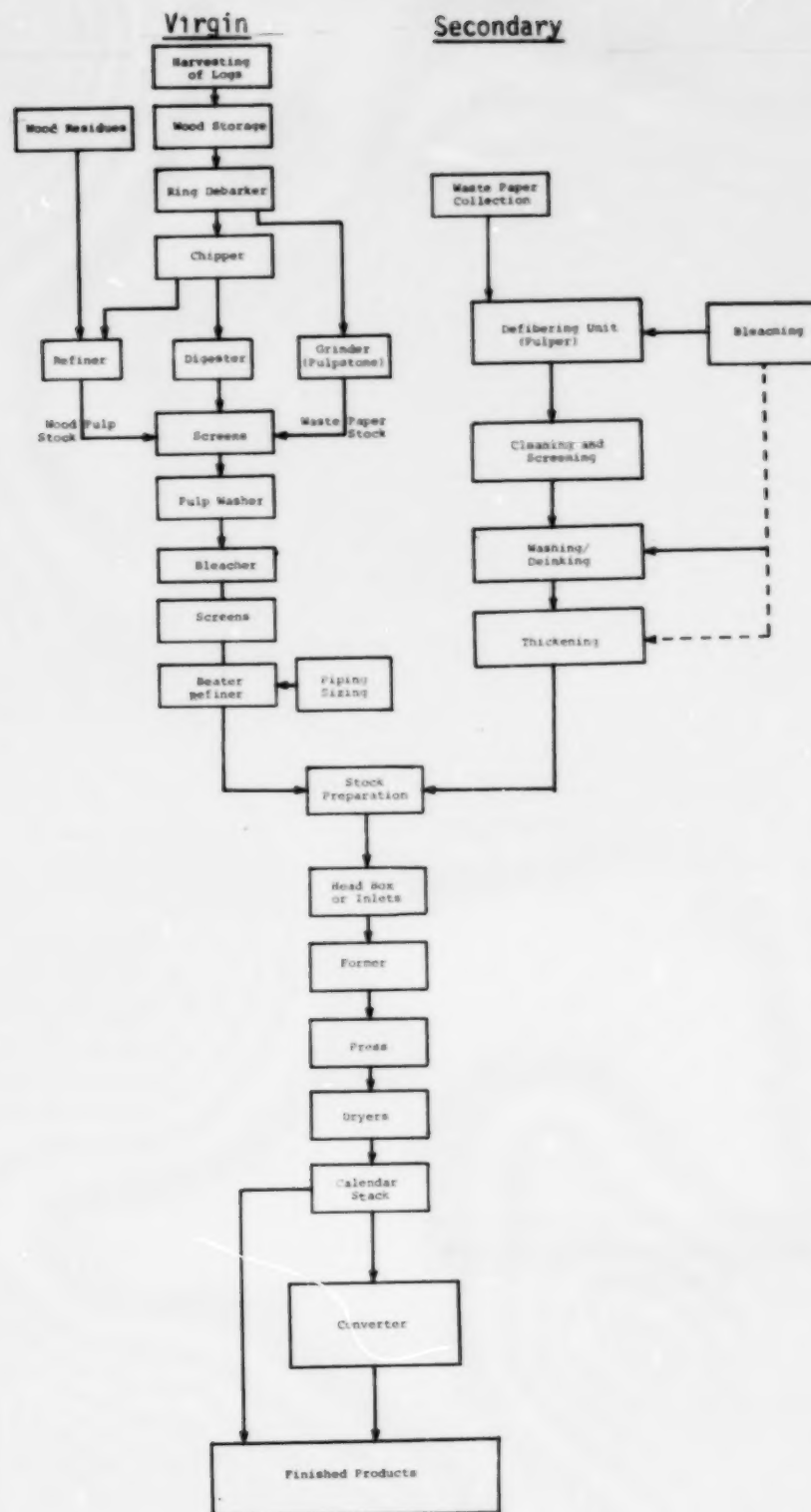


FIGURE III.1 PROCESS FLOW

paper grades; b) level of contamination; c) complex mix of fiber characteristics and substitutability; and d) current plant design. (Appendix III provides a detailed breakdown of secondary fiber usage.) Fiber characteristics appropriate to any specific end product involve a complex mix of parameters. The implications are that secondary fiber may be determined technically advantageous or disadvantageous only by analyzing specific factors for the relevant production process and product use. Post consumer waste is at an absolute disadvantage relative to virgin fiber resulting from contamination, misclassification, and a smaller body of research and experience.

CHAPTER IV: INDUSTRY MORPHOLOGY

Chapter IV characterizes the paper industry in terms of business strategy and organizational structure. The analytical course adopted for data examination is the use of a conceptual framework describing the investment process. The framework provides a guide for data categorization and analysis.

Investment Process Model

The investment decision had been characterized by two major models: the financial model and the process model. The financial model, in its quantitatively elegant and normative fashion, relates the corporate investment decision to the selection of an efficient portfolio of projects, where measurable parameters of return and relevant risk are the important variables.¹ Bower's survey of descriptive literature "resolves negatively" the applicability of the portfolio based model to the capital budgeting process in the non-financial firm.² In Managing the Resource Allocation Process he goes on to develop a descriptive and normative model of investment decision making. It is Bower's process model, where investment and business planning are intimately connected, which this paper adopts as a conceptual framework.

Phases of the Investment Process

The investment process, according to Bower's process model, is composed of three phases: 1) a product/market discrepancy; 2) definition; and 3) impetus.³ A discrepancy is created when "routine demands of a facility-oriented job indicate the need for a new facility."⁴ This discrepancy between what is required of a manager and what he is able to deliver may arise along three lines: capacity, costs, or quality. These are summarized in Table IV-1.

The initiating phase of the definition process begins with a product/market discrepancy and with plans and activity measures being in strategic form. Strategic

Table IV-1. SOURCES OF DISCREPANCY^a

DISCREPANCY		EVIDENCE	SOURCE OF EVIDENCE
Capacity	insufficient	sales exceed capacity	marketing
		forecasts exceed capacity	marketing
		new product	engineering development marketing general management
Costs	too high	input costs have risen	accounting data
	may be lowered	prices have fallen	marketing
			production or engineering
Quality	inadequate	competitive improvement	marketing
		customer need	marketing
		prices have fallen	marketing
	may be improved		engineering

^aSource: Joseph Bower, Managing the Resource Allocation Process.
op cit, p. 53.

measures involve such elements as "market size and share, price, margins, operating efficiencies, technological competitiveness."⁵ The strategic nature of initial definition may be contrasted with the more narrow measures of financial planning, i.e., return on investment (ROI), earnings per share (EPS) growth, cash flow. Before approval, and normally as the definition moves up in the corporate hierarchy, strategic plans are translated to aggregate financial plans and measures, and a corporate view of a company/environment discrepancy.⁶ The translating, or integrating, phase of the definition process relates strategic product/market goals to corporate goals and relates, through context, corporate goals to products (for instance, by setting a pro forma ROI hurdle rate).

Impetus is defined as the "force that moves a project toward funding."⁷ At its lowest level it is the "willingness of a general manager ... to commit himself to sponsor a project in the counsel..."⁸ of superiors. At the other extreme, impetus is the "yes" or "no" decision of the highest corporate group ruling on the investment. Aharoni indicates that such commitments represent "a state of mind, a feeling that guides action, not a legal obligation", and, as such, may be made by "bureaucratic arrangements or individual adjustment to social position."⁹ Thus, the building of a commitment may be the sum of a series of small events. The sponsoring of projects is part of a general manager's job,¹⁰ and he does so when, by his interpretation of the "rules of the game," it is in his best interest.¹¹ Inputs to the commitment decision include both an evaluation of the quality of the project and of the risk and reward distribution of sponsorship. The latter is strongly dependent on context.

Context of Paper Industry Decisions

Context is defined by Bower as "the set of organizational forces that influence the processes of definition and impetus."¹² Context is segmented into structural and situational elements. The latter refer to personal factors unique to each situation and thus, although important in individual cases, outside the scope of this study. Structural context encompasses the elements of corporate structure which are under management control.

These include: "the formal organization (with associated definitions of managers' jobs); the system of information and control used to measure performance of the business; and the systems used to measure and reward performance of managers."¹³

In this paper we shall use a somewhat broader definition of context as our framework. Following the efforts of Alfred Chandler¹⁴ and Bruce Scott¹⁵ concerning stages of corporate structural development, and of Richard Rumelt¹⁶ concerning the measurable financial impact of strategy and structure, this paper characterizes the context of paper industry decisions principally in light of industry strategy and structure. Strategic context herein refers to the strategic business plan. Structural context refers to the organizational control mechanisms which overlay and shape corporate processes. We shall include social context to mean any generalizable corporate or industry attitude norms. Of course, the three types of contexts interact at many levels of cause and effect, but contextual analysis provides an excellent framework for building an overall industry understanding in a research setting.

Strategic industry understanding is important to this paper because it presents a framework for comparing and understanding alternatives available. This understanding can shed light on the required rate of return on investment for engaging in products, projects, or processes, like recycling. Similarly, analysis of strategic characteristics may enlighten us regarding the interface between any proposed program, including increased recycling, and present business strategy. The shape of this interface influences acceptance of the proposed strategy in terms of risk and required return.

The structure of an organization informs us of the nature of the allocational process and the management level at which specific types of decisions are made. Literature¹⁷ on structure and corporate growth provides an understanding of internal transactions and decision making "style," or context, differentiated by structure. This knowledge provides benchmarks for an analysis of corporate decision making as its structure affects any particular proposal, i.e., the interface between a proposed activity and organizational structure.

The remainder of this chapter outlines the strategic and structural contexts of the paper industry. In many ways it anticipates the field data in drawing conclusions from the statistics presented. The purpose of presenting such a detailed framework at this stage is to allow the field research to fall readily into a meaningful pattern. Although social context is not discussed explicitly until Chapter VII, the reader will see elements in this chapter which are relevant to it.

Strategic Context of the Paper Industry

The strategy of the paper industry may be classified Dominant Vertical, ¹⁸ meaning that the majority of products produced and sold are outputs linked to a vertical processing chain which represents a large percentage of total corporate sales. As the field research will indicate, even when the vertical chain represents less than 70 percent of total legal entity sales, many of the characteristics outlined here still apply. Table IV-2 shows the overwhelming trend toward becoming an integrated producer of different specific paper and board products, all related to the same processing chain.¹⁹ This period of integration, both forward and backward, was characterized by substantial merger activity, as shown in Figure IV-1.

The strategy of the paper industry is very similar to that of primary metals and oil as displayed in Appendix IX.²⁰ These are industries whose strategy is apart from the main trend of the U.S. economy. In general, they increased vertical integration instead of diversifying into less related areas. The economy-wide pattern is shown in Appendix X.

Rumelt has compared the financial characteristics of various strategies. He found that high profitability strategies were usually "associated with high rates of growth, lower amounts of profit variability, and higher price-earning multiples."²¹ This allows categorization of performance by strategy:

Table IV-2. PAPER INDUSTRY TREND TOWARDS DOMINANT^a
VERTICAL BETWEEN 1949 AND 1969

	Percent of Rumelt's Sample of Fortune 500 Paper Companies	
	1949	1969
Single Business (specialization ratio 2.95)	54	10
Dominant Vertical	38	60
Dominant Non-vertical	8	10
Related	--	20

^a Source: Percentages calculated from Rumelt, *op. cit.* pp. 180-181. Due to small size of his random sample, these figures should be used as a trend guide only. Full definitions appear in Appendix VIII.

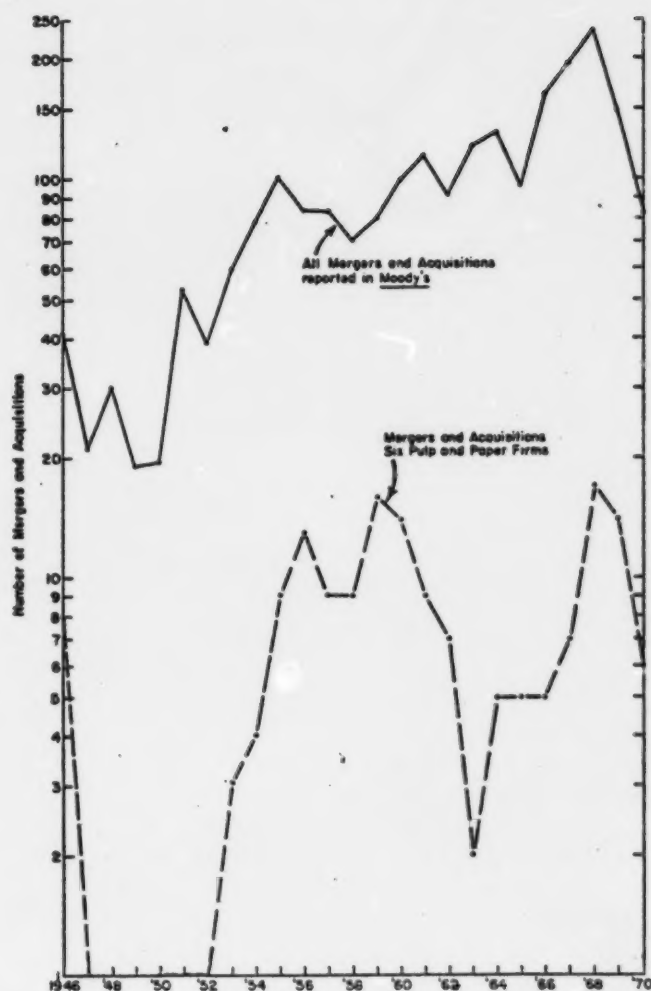


Figure IV-1. Comparison of Mergers in Pulp and Paper with all Industrial Mergers Reported in Moody's 1946-1970. Source: John A. Guthrie, *An Economic Analysis of the Pulp and Paper Industry*. Pullman, Washington: The Washington State University Press, 1972, p. 183. The six firms in the paper sample are: International Paper, Mead, St. Regis, Crown Zellerback, Kimberly-Clark and Scott.

Performance by Business Strategy²²

<u>High</u>	<u>Medium</u>	<u>Low</u>
Dominant constrained	Related linked	Dominant vertical
Related constrained	Single	Unrelated passive
	Acquisitive con- glomerate	

Specific financial variables behind this categorization of performance by strategy may be seen in Table IV-3.

What are the characteristics of an industry with a Dominant Vertical (DV) strategy that produces both a low ROI and continued investment? The answer to that question will help us understand the paper, steel, oil and rubber (SIC 30)²³ industries. Chandler, Ackerman, Scott, and Rumelt, in separately cited works,²⁴ provide a preliminary set of characteristics associated with the DV strategy, upon which this research expands. An outline of major elements common to this strategy appears in Table IV-4. Exposition of these characteristics provides the opportunity for coherent presentation of much of this author's research into the paper industry. While many of the individual points raised are not unique to dominant verticals, their coincidence stamps a significant pattern.

Absolute and Increasing Capital Intensity

Paper, petroleum and primary metals are all relatively capital intensive compared with typical manufacturing, as shown in Table IV-5. One reasonable explanation is the applicable plant economics of scale function by which plant costs are related to capacity in an exponential formula:²⁵

$$\frac{K_1}{K_2} = \frac{O_1^{\frac{2}{3}}}{O_2^{\frac{2}{3}}}$$

where K_1 and K_2 are capital costs for different size plants and O_1 and O_2 are capacity outputs. In paper, a larger plant also brings employment economy; i.e., it

Table IV-3. FINANCIAL PERFORMANCE BY STRATEGY^a

	Dominant			Related		Unrelated		
	Vertically integrated	Closely related	Linked & unrelated	Closely related	Linked	Passive conglomerate	Acquisitive conglomerate	
Single business								
Sales growth	7.17	7.42	9.48	6.93	9.62	8.06	6.10	20.64
Earnings growth	4.81	7.34	9.08	8.10	10.39	7.15	7.78	18.64
Earnings per share (EPS)	3.92	5.14	7.60	6.11	8.56	5.57	5.96	9.46
Price/earnings (P/E)	14.60	15.68	15.92	15.41	19.19	19.27	13.77	17.43
ROI	10.81	8.24	12.71	8.69	11.97	10.43	9.40	9.56
Return on equity (ROE)	13.20	10.18	14.91	10.28	14.11	12.28	10.38	13.13

^aSource: Rumelt, op. cit., p. 166. Numbers are for 1959-1969 decade. Definitions appear in Appendix VIII.

Table IV-4. CHARACTERISTICS OF INDUSTRIES PURSUING
THE DOMINANT VERTICAL INTEGRATION STRATEGY^a

1. Absolutely and Increasingly Capital Intensive
 2. Commodity Nature of Products
 3. Capacity Cycles
 4. Distribution of Capital Intensity
 5. Continuing Pressure to Integrate
 6. Production Rather than Market Orientation
 7. Non-Extensible Technology
 8. Non-Extensible Management Skills
 9. Mechanical Diversification Difficulty
 10. Complex Functional Relationships
-

^aSource: Resource Planning Institute.

Table IV-5. BOOK VALUE OF ASSETS PER EMPLOYEE, 1964^a

	<u>Dollars</u>
All manufacturing	10,188
Paper and allied products (SIC 26)	20,170
Petroleum and coal (SIC 29)	73,149
Primary metals (SIC 33)	23,059

^aSource: U.S. Department of Commerce, Industry Profiles 1958-1969, 1971.

takes the same number of men to run a paper machine, regardless of width. Appendix XI illustrates the size distribution of U.S. mills, clearly implying economies of scale. Appendix XII shows the higher capital charges (depreciation, amortization) as a percent of sales for paper and allied products than for all manufacturing.

In recent decades capital intensity in the paper industry has been increasing at an increasing rate.²⁶ Appendix XIII shows the increase in typical mill size between 1955 and 1965. New kraft board mill sizes have gone from 600-700 tpd to 1000-1200 tpd in the 1965 to 1972 period.²⁷ In addition to the resultant total plant cost increase, capital costs per daily ton have risen from \$55,000 to \$94,000.²⁸ This has occurred during a period in which kraft prices did not rise.²⁹ A well-regarded industry economics firm estimates that the cost per daily ton will rise to \$115,000 in 1975, based on figures received from companies and engineering firms engaged in building such mills.³⁰ This means the cost of a new kraft mill will about double in the 1965-1975 decade, while it took the two previous decades, 1945-1964, for it to double before.³¹ During the period 1945-1965, kraft increased in price less than 25 percent.³²

The increasingly capital intensive nature of the paper industry is further reflected in Appendix XIV, which displays the increase in fixed assets as a percent of total from 41 percent in 1950 to 67 percent in 1967. This is coincident with an increase in depreciation and amortization as a percent of total receipts from 2 percent to 4.5 percent. The increase in fixed/total asset percentage has been paralleled by an increase in long term debt-equity ratios from 13.7 percent in 1950 to 49.7 percent in 1971, as shown in Appendix XV.

Commodity Nature of Products

Paper, oil, and metal industry products tend to be of a commodity nature, with products basically differentiated generically rather than by brand. This is a function of the industries' maturity and of the products' uses as inputs to other processes. To the extent that products are inputs to other production processes standardization is desired by users. Even in the case of final products like tissue, the process of turning similar natural raw materials into a form for a specific end use results

in a series of commodity products, often differentiated only by advertising.

Evidence of industry maturity may be found in the presence of a standardized and widely available technology. It would be fair to say that "anybody" could go into the paper business. Like steel, paper invests a very low percentage of sales in research and development, as illustrated in Appendix XVI which shows R&D as .7% of net sales for SIC 26 as compared to 4.1% for all R&D performing manufacturing in 1968. Similarly, advertising is shown in Appendix XII to represent a relatively low percent of sales, .8% versus 1.44% for all manufacturing. The commodity product nature and easily available technology, combined with diversified resource locations and paper product types, may underlie the relatively low industry concentration, considering capital intensity.

The fact that a product is of a commodity type and is so viewed by its consumers does not mean that producing firms consider their products equivalent; products like kraft pulp may be differentiatable along measures not affecting their interchangeability. Efforts to establish a more efficient market in pulp, paper and board products have met with apparently sincere resistance over this point. Dr. Borje Steenberg of the UN Food and Agriculture Organization suggested that the industry spent too much time and money attempting to differentiate products which were essentially identical.³³ In the case of pulp, for example, world purchasers, not necessarily U.S. integrated producers, take care to diversify supply sources in order to guarantee their capital intensive manufacturing operations adequate input, and change sources of pulp with changing market conditions.³⁴ This implies that advertising expenses for product differentiation would not be recovered and could partially explain poor industry performance. Dr. Steenberg's proposal of a future's market requiring fungibility met with replies characterized by: "There is no way you can sell a Northern jackpine kraft and a Southern pine kraft and call them the same. When Western hemlock and Douglas fir pulps were introduced, they were entirely new pulps."³⁵ The similarity should be noted with the steel rail situation in an earlier time. The Pennsylvania Railway precipitated a slump in steel stock prices by announcing the decision to purchase rails on standard specifications. As Steenberg notes sarcastically, "How could a steel producer develop

business and make money if he was (sic) not allowed to claim that his rails were better than all the others in the country, and that what the country needed was exactly his brand of rails?" 36

The American Standards Association (forerunner of the National Standards Institute) tried from 1947-1950, at the request of the National Office Management Association, to develop standards for paper but was unable because:

manufacturers concluded that, while folding endurance, bursting, and tear strength could be measured, more important features, such as appearance, formation, printability, lack of curl and performance on printing press defy accurate measurement. 37

Even if the firm recognizes interchangeability it may not behave like the classical perfect competitor. Exigencies of capital intensive production processes push firms into guaranteeing markets wherever possible. Three logical strategies for success in this paper industry environment may be identified:

- (1) encourage monopolistic or oligopolistic markets;
- (2) always aim to be the low cost producer;
- (3) attempt product differentiation.

Lack of concentrated industry power seems to rule against oligopolistic control for the paper industry. Appendices XVII and XVIII present concentration ratios for some segments of the paper industry. On average, these represent relatively low concentration ratios considering investment size. Industry maturity, widely available supply sources, and commodity products may be offered in explanation. Not surprisingly, pulp mills, the highly capital intensive primary processing units (as illustrated in Table IV-7), are more highly concentrated than converting plants (Appendices XVII and XVIII). Tissue is concentrated because of product differentiation based on advertising, a market approach requiring substantial advertising capital and time, both barriers to entry. Where concentration permits oligopolistic power to be used, it is. Industry sources

indicate this is the case in tissue. But, overall, the paper industry appears competitive. One may contrast this situation with the Federal Trade Commission alleged oil industry attempts to employ oligopolistic power.

The second market strategy, aiming to be the low cost producer, is generally followed in the industry. This reinforces the perpetuation of many of the characteristics being enumerated: increasing capital intensity, commodity nature of product, and production orientation.

The third marketing approach is to attempt product differentiation. For tissue this has meant advertising. For folding boxboard it has meant offering a package design service. Linerboard tries to compete on strength/weight types of measures. The true commodity nature of these products is illustrated by the elimination of price differentials between certain specifications of the same basic grade under conditions of full capacity. Also, it often happens that a folding boxboard maker will use his "special" abilities in offering a product to a client on a very individualized basis (specific design, color, brightness, etc.) only to have his design shopped to other box makers. The fact that attempts at product differentiation may encourage forward integration is illustrated by an integrated firm president's remarks:³⁸

With the growth in packaging markets, it became obvious to us in the early 1950's that our policies and emphasis should be modified to overcome the barrier between our company and the market place. We did this initially by developing new paper types and grades. However, we found that our products were not getting the proper recognition in the market place which then led us to consider and actually enter into the manufacture of bags, cartons, and other converted products.

The above does not imply that "commodity products" may not experience healthy growth in sales. This happened in oil through product development not related to oil industry efforts. This has happened with paper because its demand, although price inelastic, has risen with a growing economy, as Appendix Table III.1 shows. One of the reasons that total paper sales have grown may be a result of its commodity nature: its price is low in relation to substitutes.³⁹

The commodity nature of paper products implies returns on net worth equal to or below all manufacturing. This is illustrated in Table IV-6.

Capacity Cycles

In a commodity industry with price inelastic demand because the products are inputs to other processes, "profitability is largely contingent upon the balance between capacity and demand."⁴⁰ The chronic nature of cycles in capacity and thus profitability are characteristic of these industries. Capacity cycles are the result of "mature industries producing near commodity products that require quantum step investments."⁴¹ Quantum step investments imply a long lead time (at least two years in the paper industry). Because investments are large, the economy difficult to predict, and the economics of capital intensive commodity production such that operating rates are critical to profitability, commitments to major new investments are usually undertaken during periods of full capacity operation. These periods tend to be the same for most similar paper products, partly because capital intensity has made firms build product flexibility into their large plants to reduce risks. Also, market data received by different firms tend to be similar: the American Paper Institute provides the same demand projections to hundreds of companies, and Mackay Shields Economics, Inc. provides very widely used projections on a private consulting basis. The coincidence of the following factors, along with those that discourage diversification, spell chronic capacity and profitability cycles:

- . lead time longer than accurate prediction of industry capacity;
- . quantum and irreversible nature of investment;
- . similarity of environment perception; and
- . competitive commodity-product industry structure without oligopoly.

Capacity, capital expenditures, operating rate, and profitability cycles are illustrated in Appendices XIX and XX. It is increasingly felt in the industry⁴² and

Table IV-6 . PROFIT AFTER TAXES AS A PERCENTAGE OF
SALES AND NET WORTH^a

	IRS DATA % of Sales		FTC % of Sales		IRS % of Net Worth		FTC % of Net Worth	
	All Manufac. Indus.	Paper & Allied Products	All Manufac. Indus.	Paper & Allied Products	All Manufac. Indus.	Paper & Allied Products	All Manufac. Indus.	Paper & Allied Products
1950	6.1	8.1	7.1	8.8	13.4	14.4	15.0	15.6
1951								
1952								
1953								
1954								
1955	4.4	5.9	5.4	6.1	9.9	9.9	12.3	11.2
1956	4.0	6.4	5.3	6.1	8.8	10.7	12.0	11.4
1957	3.5	4.7	4.8	5.0	7.7	7.8	10.7	8.9
1958	2.8	4.0	4.2	4.5	5.8	6.6	8.4	7.3
1959	3.5	5.1	4.8	5.2	7.8	8.9	10.2	9.3
1960	3.0	4.4	4.4	5.0	6.4	7.4	9.1	8.4
1961	3.0	4.1	4.3	4.7	6.3	6.8	8.7	7.7
1962	3.3	3.9	4.5	4.6	N.A.	N.A.	9.6	8.1
1963	3.6	3.9	4.7	4.5	7.8	6.6	10.1	8.0
1964	3.9	4.2	5.2	5.1	8.6	7.2	11.4	9.1
1965	4.5	4.7	5.6	5.4	10.2	8.7	12.6	10.0
1966	4.6	5.2	5.6	5.4	10.8	9.5	13.1	10.5
1967	4.0	4.4	4.8	4.7	9.0	8.1	11.4	8.3
1968	3.7	4.2	5.1	4.7	N.A.	8.2	11.7	9.5
1969	3.0	4.0	4.8	4.8	N.A.	N.A.	11.2	9.7
1970			4.0	3.4			9.2	7.0
1971			4.1	2.3			9.5	4.9

^aSOURCE: IRS Percentage Data calculated by API from the IRS, "Statistics of Income, Corporate Income Tax Returns". FTC-SEC percentages calculated from "Quarterly Financial Report for Manufacturing Corporations". API, "A Capital and Income Survey", 1971.

on Wall Street⁴³ that the industry will not repeat the cyclical pattern of the past by entering an overcapacity situation. The reasons offered this author from both sources are:

- a) low pro-forma returns resulting from price controls;
- b) increasingly financial orientation of the industry;
- c) large pollution control expenditures (Appendix XXI) reflecting the high level of pollution control expenditures required in the next five years, particularly when considered relative to the total capital expenditures of Appendix XX;
- d) lack of cash availability resulting from low profits, an already leveraged position, and low P/E's;
- d) failure of mill sizes to increase at the past rate due to points c) and d), energy shortages, wood and labor supply difficulties, and a decreasing number of potential new mill sites; and
- f) mill sizes relative to total production are smaller as a result of point e), thus reducing the impact of the quantum step nature of investment.

We assert that the coincidence of the first four factors with the characteristics of the preceeding paragraph would amplify the next cycle. Pollution control expenditures will hold down the less return-justified strategic capacity additions for several years. Price controls and a financial orientation imply higher hurdle rates which will postpone investment from a rate of return standpoint, even in these full capacity times. However, different "book", or historically based, wood costs would cause different investment timing for different firms even with similar hurdle rates. Higher prices could result from a reduction of price controls if at the same time there existed capacity inadequacy. If this should coincide with lessened pollution control expenditure requirements and high profits from a sustained 100 percent

operating rate (a reasonable expectation within the next several years), even more serious cyclicalities would result. A clear resolution of these opposing arguments concerning capacity cycles is not possible, but we assert that the weight of history and current capacity postponement imply continued significant cyclicalities.

Distribution of Capital Intensity

The primary processing step in the vertical chain, usually well removed from final product use, tends to be the most capital intensive part of the industry under study. Table IV-7 illustrates this clearly. The significance of this capital distribution is the centering of organizational power and concern on the primary, commodity product, production process, and the tendency to regard later steps in the vertical chain as outlets to guarantee demand for the all-important primary product. Not surprisingly, concentration ratios tend to follow the pattern of capital costs, as illustrated in Appendices XVII, XVIII, and XXII.

The end result of this is an almost total focusing on the low cost production of a primary product. In a capital intensive, mature technology industry, this means keeping operating rates high. This requires guaranteeing sales by integrating forward. Because the units of forward integration are less capital intensive, and on an absolute level much less costly, they are perceived as a low risk way of guaranteeing profitability of the primary operation. Viewed as a risk reduction technique for primary processing, the forward units are allowed to operate at marginal return levels without generating concern. This explains the proliferation of gas stations and the paper industry's historic and well-accepted pattern that profits are lower in converting than in pulping. The latter is due to many factors in addition to those mentioned above, but the important point is that the unit at the market/DV interface is not expected to be very profitable. This insulates management from the world in which their products compete, perpetuating the next two characteristics: continuing pressure to integrate and production rather than market orientation.

Table IV- 7. DISTRIBUTION OF CAPITAL INTENSITY IN
VERTICALLY INTEGRATED INDUSTRIES ^a

	Book value of assets per employee (1964)
Paper	
Pulpmills	61,917
Papermills	34,018
Paperboard mills	43,247
Bags (sic 2643)	9,121
Wallpaper (sic 2644)	6,840
Paperboard containers and boxes (sic 265)	9,668
Steel	
Blast furnace and basic steel products (331)	31,671
Steel wire (3315)	12,758
Aluminum	
Primary (3334)	65,168
Rolling and drawing	23,244
Petroleum	
Refining (2911)	90,433
Lubricating oil (2992)	16,054

^aSource: U.S. Department of Commerce, Industry Profiles
1958-1969, 1971.

Continuing Pressure to Integrate

The distribution of capital intensity combines with absolute and increasing capital intensity (which, because of high risk of loss with operating rates, requires demand and supply guarantees) and rising debt levels to provide continued pressure to integrate and expand in the same business lines for defensive reasons. Integrated firms show both higher absolute returns and smaller relative fluctuation in profit after tax versus sales. Appendices XXIII and XXIV illustrate the larger mill size and superior financial results of integrated firms.

Backward integration to supply sources is implied by the demands of operating rate-sensitive primary processing. Appendix XXV illustrates the trend toward supply source ownership or control. By 1971, 89 percent of the annual new supply of wood pulp was from captive sources.⁴⁴ The possibility of long term fiber shortages reinforces the current demand for guaranteed supply. Appendix XXVI indicates that backward integration is most significant for kraft, the most capital intensive industry segment, where 98 percent of the new supply was from captive sources in 1971.⁴⁵

On the demand side, weak market conditions, or fear thereof, offer the impetus for forward integration into converting in order to guarantee demand for primary processing. Lower capital intensity in converting, as reflected in Table IV-7, than for paper or board manufacture, implies the desirability, under weak market conditions, of running converting operations at less than capacity rather than underutilizing primary processing facilities. This is reflected in the willingness to book low converting profits and to define a converting capacity discrepancy in terms of internal needs in a weak market. (This point is elaborated in Chapter VI.)

An industry strategy of integration is self-reinforcing to the extent that it makes captive supply and demand even more important. For example, the move to converting in the 1950's has been described by one folding boxboard company president as "a matter of defense rather than a search for higher returns. We had to get into the conversion business because of the integration that was taking place in the industry. Our customers were being bought up by our competitors."⁴⁶

Capacity increases lead mergers and acquisitions as Figure IV-2 illustrates. A reasonable explanatory hypothesis would be that with each new round of capacity increase the ante required to stay in the game is raised. Weaker firms use their merger partner or acquirer as a capital source.

Integration is lower at the converting stage than for pulp, as indicated in Appendices XXVII and XXVIII. Several factors help explain this. Much higher concentration (perhaps resulting from capital intensity) exists for pulp in conjunction with very limited external markets. This implies a greater necessity to insure supply. The shorter lead time, market oriented, lower capital intensity of converting ⁴⁷ locates most non-integrated firms at that stage, providing a broad external market for primary products. Also, the quantum step nature of primary processing capacity expansion relative to converting capacity expansion implies an excess of primary capacity before the desired internal balance is re-attained. Often four or more market-located converting plants are required to absorb production from one primary processing facility. As we shall see, structural context exaggerates the internal imbalance discrepancies.

Production Orientation

Capital intensity and its distribution, combined with the semi-commodity nature of a product, imply concern with process and production rather than market. A company is in the paper business, not the making money out of the shipping packaging business. The organizational structure of vertically integrated firms, as will be discussed in detail later, when combined with the factors making diversification difficult and with production orientation, allow the perpetuation of process orientation by making performance measurement comparisons on an industry or historical basis. This means new investment may be justified because it provides slightly lower costs than competitors or a slightly higher return, even if this is an uneconomically low return from an economy-wide viewpoint.

Rumelt points out that DV industries usually develop "values and attitudes that assign specific existential

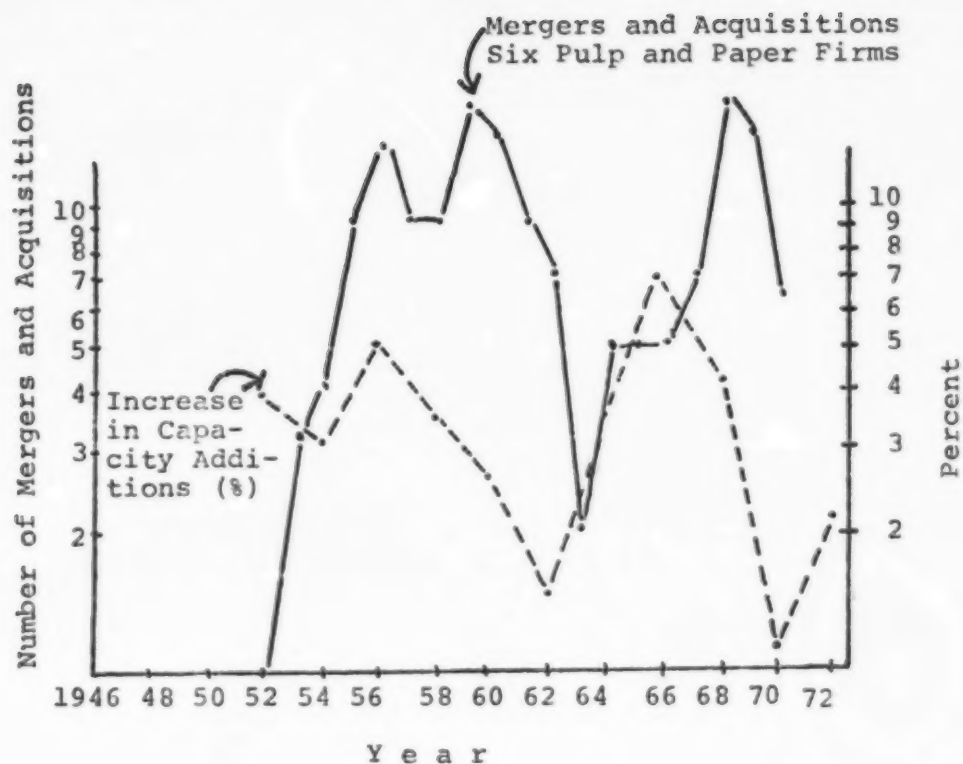


Figure IV-2. Comparison of Mergers in Pulp and Paper with Capacity Increases in Paper and Paperboard. Source: Mergers and Acquisitions from John A. Guthrie, *op. cit.*, p. 183. The six firms in the paper sample are: International Paper, Mead, St. Regis, Crown Zellerback, Kimberly-Clark and Scott. Capacity increases calculated by Smith Barney based on American Paper Institute Data, "The Paper Industry - Another Decade of Disappointment?" New York, 5/18/73.

worth to the products or processes themselves."⁴⁸ He cites the following statement by an economist before the Senate Subcommittee on Anti-Trust and Monopoly:

I would like to just mention an industry which has not diversified, which is vertically integrated, and yet has complained perhaps more vigorously than any other industry over a period of years before this committee and elsewhere about its low level of return and profits. I refer to the steel industry. The absence of diversification of large steel firms is, perhaps, surprising. One of the firms will endeavor to move from relatively low-return lines to more profitable businesses. Large firms in steel have been unwilling or unable to diversify out of steel, in spite of their sizable internal flows of funds, and in spite of the fact that the industry is characterized by excess and obsolescent capacity and by steadily increasing competition from substitutes. A partial explanation...may be that steel executives regard themselves not as having gone into business but having adopted a way of life.... It is interesting that when one of the more profitable steel companies, National Steel, speaks of diversification, it means not that it is going to move into other industries but that it will attempt to reduce the reliance on the automobile industry for outlets.⁴⁹

This is not like the situation in the Dominant Constrained category, where those firms whose principal business performed poorly diversified in a search based on return, as illustrated below:⁵⁰

<u>Firms that were Dominant Constrained in 1949-59</u>	<u>1951-1959 ROE</u>	<u>Average Growth in Earnings Per Share (EPS)</u>
And stayed Dominant Constrained during the decade 1960-69	17.4	11.7
And diversified out of the Dominant Constrained group in 1960-69	13.4	6.7

The maintenance of relative operational efficiency is very important to relative profitability. This requires incremental improvements to machines, since competitors are making them, and the gradual increase of paper or board machine capacity over its installed capacity. Industry sources indicate that with experience and incremental modifications it is usually expected that a new paper machine will experience increases in its capacity of about 10 percent, in 2 percent annual increments. Such incremental investment is encouraged by the accounting system since capital costs for the facility have already been fully allocated.

The concern for operational efficiency is interestingly illustrated by one specific proposal for a wastepaper mill. A major board producer wanted to add recycle board capacity in order to meet GSA specifications for its corrugated containers. The kraft planning department was asked to undertake a study of a wastepaper mill. The figures were manipulated to look better than actually anticipated since it was believed the alternative to a new mill was the introduction of waste pulping equipment into a virgin mill. The waste pulping facility, in order to use the excess paperboard mill capacity over virgin pulp mill capacity, would have required a smaller capital investment than an increment of virgin pulping capacity. However, introduction of foreign furnish into a large, efficient mill was feared to seriously damage economic performance as a result of seemingly minor inconveniences. Mill personnel apparently are well aware of the dollar cost per minute of down time.

Production orientation adds to the industry's problems since:

In a mature, slowly growing industry, the constant...struggle to be a low cost producer and provide flexible and geographically dispersed capacity almost insures industry over capacity (on the average) and poor profitability for all."⁵¹

Non-Extensible Technology

Research in DV industries is production rather than product oriented. It is aimed at efficiency and low cost.

The nature of products and integration strategy in DV industries pre-dates the newer, easily diversifiable technology industries.⁵² Chandler has noted the importance of new technology and new markets in growth by diversification.⁵³ In DV industries techniques and research are related to single processes which have proven rather non-extensible, certainly when compared with knowledge related to things electronic.

Vertically integrated companies have a commitment to their major process for previously identified reasons, not to a market oriented function. Thus, plastic bags are a threat, not a business for a paper bag maker to consider seriously. Even though forward integration is known to be a demand guarantor, it is often thought of as diversification. Paper companies, in trying to diversify, given technology and management expertise, have usually found themselves making more kinds of paper products. Of course, part of this is the result of wanting to make large and risky mill investments as flexible as possible. A paper man is not being sarcastic when he states: "We are diversified, we make all kinds of paper." The indiscriminate production of different papers contributes to the industry's low profitability.

Non-Extensible Management Skill

Process orientation and non-extensible technology combine to yield management skills that are not easily transferable. Management in a DV industry feels committed psychologically to that industry. Typically, senior corporate management has come up through the ranks. The atmosphere is not one of seeking highest return on capital, as many dominant non-verticals do, but is one of being papermakers. There is a recognized, and perhaps self-reinforcing, lack of marketing skills which make top management in the paper industry uncomfortable about new businesses. This causes the required expected rate of return for new, non-paper ventures to be substantially higher than for re-investment in the paper business. The social context is that described in Galbraith's New Industrial State: satisficing, as opposed to profit maximizing.⁵⁴

For those DV's that attempt real diversification, the picture is not much brighter. Performance of the unrelated passive strategy is no improvement relative to DV and it would be unrealistic to think that dominant vertical industries could easily become successful acquisitive conglomerates, given their management background.

Mechanical Diversification Difficulty

Several of the above characteristics result in a self-perpetuating difficulty in attempting to implement a diversification by acquisition strategy. Low financial performance results in low price/earnings ratios so that acquisition by stock of businesses in more exciting fields (thus with higher P/E's) would mean earnings per share dilution. Further, since most DV shares sell principally on dividends, stock acquisition would mean major additional cash outflows to satisfy current shareholders.⁵⁵

The financial impacts of acquisition of a more glamorous, higher P/E firm, by a DV are illustrated by a hypothetical example in Table V-8. Acquisition for stock on a dollar for dollar share price basis would require an exchange of .5 million shares of DV firm stock for the 1 million outstanding shares of Glamor firm stock. Let us assume that the DV issues .5 million new shares as part of the merger. This provides the new merged firm with 1.5 million shares outstanding (the Glamor firm's old shares being retired). The combined earnings of \$11 million yield an EPS of \$7.33, a substantial drop for the DV holders from their original \$10. If the \$5 per share dividend is to be maintained (dividends are a critical element behind a DV's share price), the total dividend payout would have to rise to \$7.5 million. This would require a high 68% dividend payout ratio. Clearly, these points imply diversification difficulty.

Acquisition by cash is equally difficult. An acquisition large enough to have a meaningful impact on earnings per share would be extremely expensive. Further, the capital intensive, process nature of the primary business requires continual re-investment in order to remain competitive.

Thus, "the integrated business keeps reinvesting because although winning is improbable, loss is certain if it does not."⁵⁶

Table IV-8. FINANCIAL IMPACTS OF ACQUISITION OF A HIGH P/E FIRM BY A DOMINANT VERTICAL^a

Financial Parameters	Before Acquisition (2 separate firms)		After Acquisition (one merged firm)
	Dominant Vertical Firm	Glamor Firm	
Shares outstanding (millions)	1	1	1.5
Earnings (\$ millions)	10	1	11
Divident payout ratio	.5	0	.68
Total dividend payout (\$ millions)	5	0	7.5
Dividends per share (\$)	5	0	5
EPS (\$)	10	1	7.33
P/E ratio	5	25	-
Share price (\$)	50	25	-
Total market value (\$ millions)	50	25	-

^a Source: Hypothetical example by Resource Planning Institute.

Complex Functional Organizational Structure

This characteristic provides transition to our discussion of structural context in the paper industry. In general, DV's have remained with an older form of organization, functional, or moved to complex combinations of functional and product divisional. The attempt to make 'profit center divisions'⁵⁷ out of stages in a vertically integrated chain will be seen to emerge as a major factor in the contextual environment of the industry, impacting capacity cycles and the recycling decision.

The Structural Context of the Paper Industry

The Scott⁵⁸-Chandler⁵⁹ "Stages of Corporate Development" model provides a framework for considering the organizational context (structure) of the paper industry. Scott's Stages I, II, and III represent a model which relates organizational development to growth, technological change, the trend toward increasing capital intensity in production and distribution,⁶⁰ and the pattern of product transactions.⁶¹ Table IV-9 illustrates the key characteristics of each stage. Basically, the stages are: single business; integrated, or functional; and product diversified, or divisional. A functional organization structure is represented in Figure IV-3, a divisional in Figure IV-4. Appendix XXX provides full definitions.

Scott's propositions concerning transition among stages are as follows: ⁶²

- a. Companies tend to add activities as they age and grow
 - activities in their traditional field(s)
 - activities in new fields.
- b. The addition of activities, the tendency for existing activities to become increasingly capital intensive, and the development of improved means of communication give rise to the development of increasing numbers of specialized organizational sub-units, with some sub-units becoming increasingly specialized as well.

Table IV-9. PRINCIPAL STAGES OF ORGANIZATIONAL DEVELOPMENT^a

Characteristics/Stages		I	II
Structure	Single unit	Functional	Divisional based on product-market relationships (products, price segments, etc.)
Pattern of internal/external transactions	No clear pattern because no clearly defined sub-units	Basically integrated	Basically not an integrated pattern
Product line	One product	One product line	Diversified
Manufacturing or operations	Limited	Integrated	Basically not integrated
Measures of performance	Personal contact subjective	Costs market share	Market criteria, ROI market choice
Key concepts of resource allocation	Between company treasury & personal fortunes of owners	Balance among functions competing for funds	Expected ROI
Rewards and punishments		Increasing systematic and impersonal	Systematic with strong impersonal element
Market'ng		Similar channels	Multiple channels
R&D		Process Operational Product } improvement	New products and processes

^a Source: Bruce R. Scott, "Stages of Corporate Development", op. cit., p. 7.

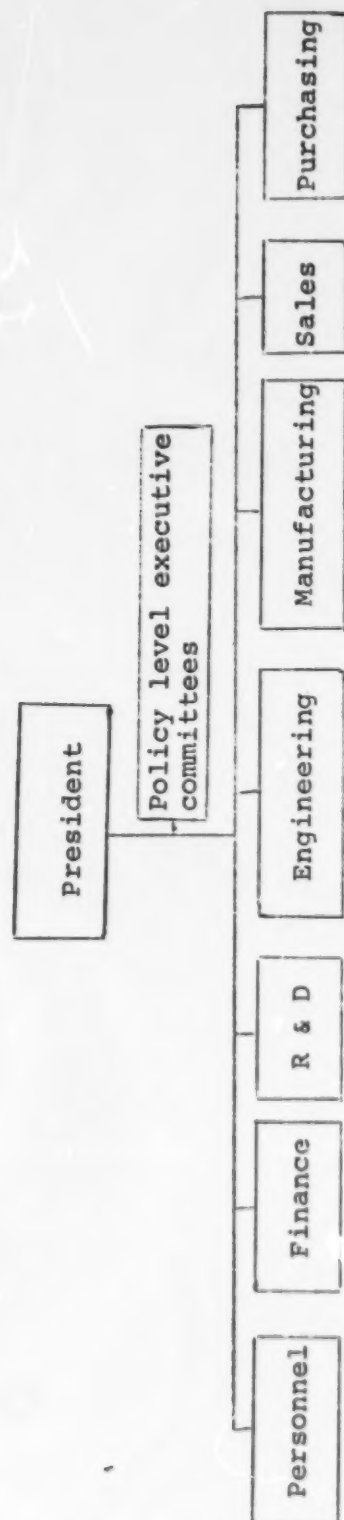


Figure IV-3. Functional Organization Chart

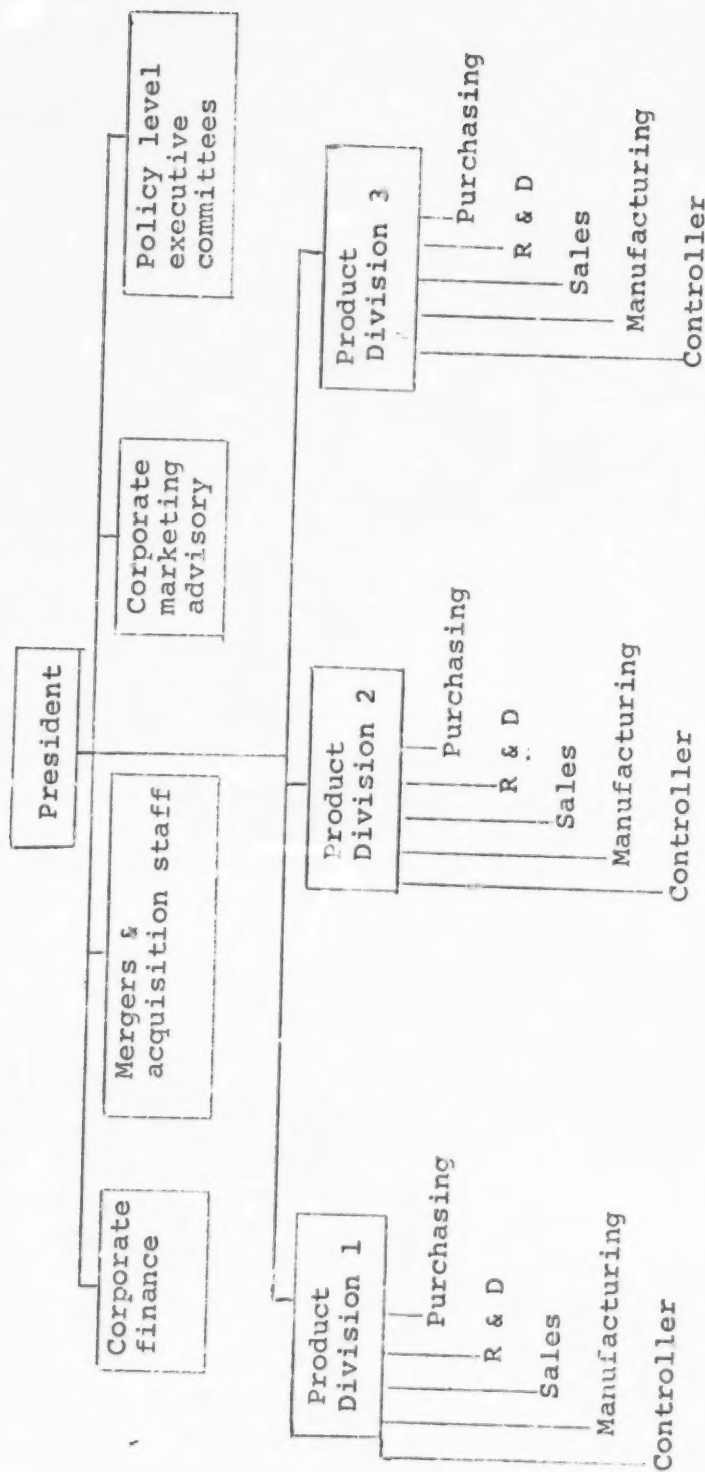


Figure IV-4. Product Divisional Organization Chart

- c. The development of an increasing number of increasingly specialized sub-units gives rise to increasingly complex administrative problems.
- d. These administrative problems appear to have been dealt with in similar fashion in various industries
 - sometimes through managers reaching similar (but independent) solutions
 - sometimes through copying.
- e. These administrative problems appear to be more closely related to the pattern of transactions involved in the flow of product or service through the various sub-units than to the technology itself.
- f. There appear to be three characteristic forms of dealing with these successively more complex administrative problems, and we have called these characteristic "solutions" Stages I, II and III of corporate development.
- g. Over time a given company will pass through these stages in a I, II, III sequence if and when it adds sufficiently to its activities
 - reaching Stage II as it increases its activities in one or a few related fields (integration)
 - reaching Stage III as it makes major commitments in several fields of activity (diversification).
- h. If, over time, a company adds only slightly or not at all to the scope of its activities, the tendency to utilize increasingly capital intensive methods of production and distribution plus an increasingly sophisticated communication system will lead in the direction of an increasingly integrated form of organization
 - leading Stage II companies to become progressively more integrated
 - leading Stage III companies which remain with a given set of activities toward a more

integrated form of organization, and perhaps eventually to a Stage II form.

Rumelt's study⁶³ of the Fortune 500 from 1949 to 1969 has substantially confirmed Scott's propositions.

Figure IV-5 illustrates the economy's dramatic shift to product divisional organizations.⁶⁴ This is particularly striking in light of the fact that the earliest divisional organization appeared in the U.S. in the first decade of the 20th century.⁶⁵ Appendix XXXI shows the organizational change by strategic class.

Most DV's are either functional (Stage II) or functional with subsidiaries (a semi-diversified Stage II), or an unusual and potentially unstable mix of Stage II with Stage III rhetoric and labels. Thus, while most steel and oil companies are functional, befitting their very integrated strategy, paper firms tend to be product divisionalized, at least in name.

It appears that in the paper industry, structure followed fashion in divisionalization. Scott's outline implies that structure would remain functional in keeping with the DV strategy. Doubtless, the move was aided by the internal perception of diversification. The industry now may represent an unstable state. U.S. Steel, for instance, divisionally organized at its formation, now resembles a functional organization.⁶⁶

The tenuous mix between functional and divisional organization complicates management and often acts to perpetuate the industry characteristics outlined in the strategy section. As to the first point, where a functional with subsidiaries organization exists, division presidents compete for funds with functional managers in phases of the primary business. To make conditions even more difficult for the division president, corporate management is almost always wedded to the primary business. The two styles of appraisal and supervision required for the successful operation of a functional with subs organization, "one for coordinating the functional departments and dealing with the strategic issues that affect the major business, often on a day-to-day basis, and another for dealing with general managers of diversified semi-autonomous divisions", are rarely combined.⁶⁷

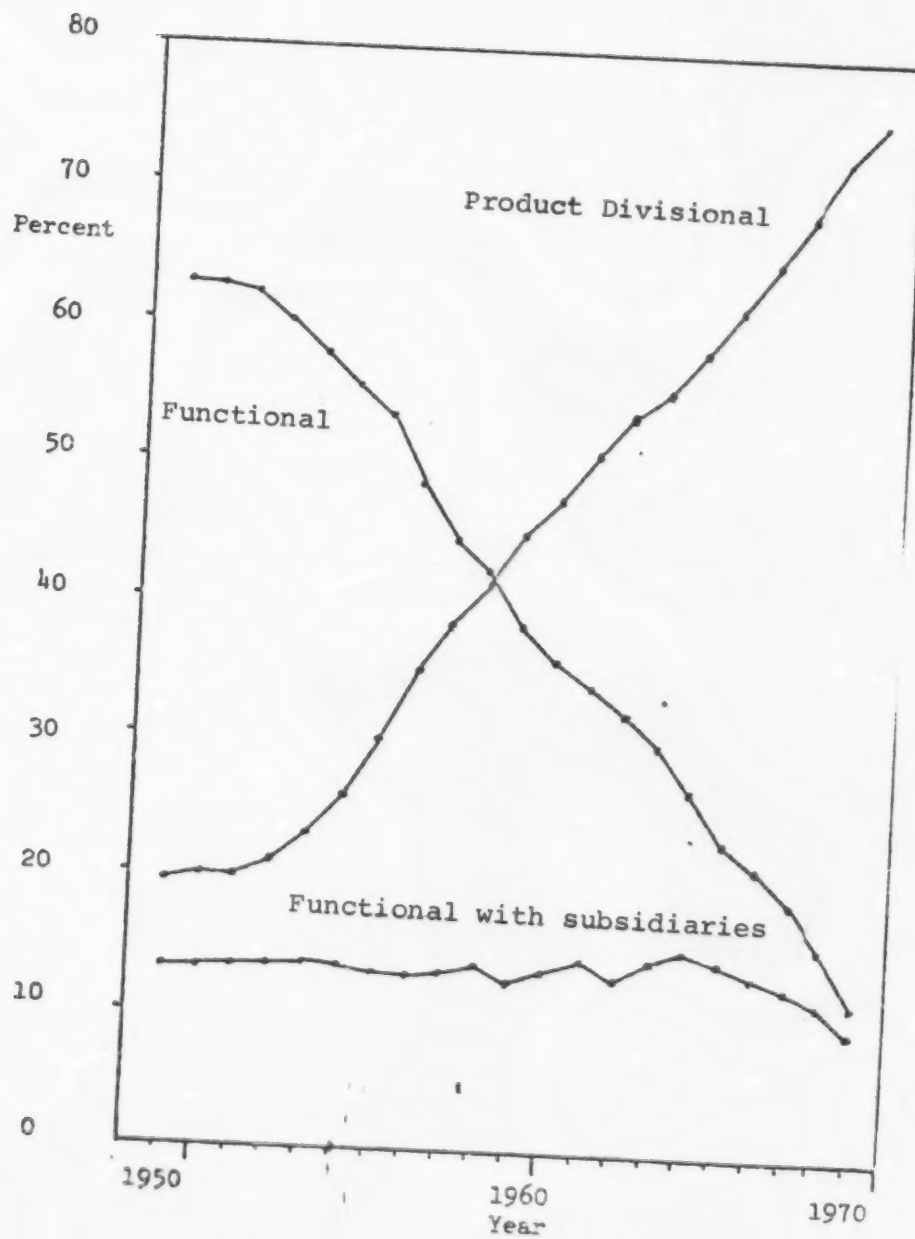


Figure IV-5. Estimated Percentage of Fortune 500 Firms in Each Organizational Class: 1949-69. Source: Rumelt, *op. cit.*, p. 114.

As to the second problem with the Stage II↔Stage III blending in the paper industry, a tendency to perpetuate strategic characteristics, it is worthwhile to examine the points of discrepancy between a paper company with "product divisions" and a model Stage III firm. Top management in an integrated paper company has almost always come through the ranks of the paper industry. Because pulp and paper or board mills have been the most capital intensive segments and where accounting profits have been generated, top management usually reinforces the emphasis on these primary processing phases. Despite the divisional titles, corporate management is usually involved deeply in specific decisions about each integrated phase in the balancing among units. Mandatory, even if only implicit, input and output allocations among divisions, often at cost based prices, reflect pressure for the functional organizational structure predicted by Scott. The fact that inter-divisional purchase policies may be mandatory by implied corporate policy, rather than written rule, only clouds a true internal perception of organizational interaction.

Assumption of the product divisional facade for the segments of the integrated chain allows an internal capacity discrepancy to justify a capital investment proposal which does not consider the impact on other divisions. This occurs even though implicit corporate policy and integration pressure imply an impact. As Ackerman notes:

Construction of a new kraft mill in an integrated company will ultimately benefit all units associated with the mill if balance is maintained. Conversely, once the mill is approved, the manager of that division must seek outlets for his paper and captive converting plants offer certain real benefits. Consequently general support from the units in this vertical chain may be anticipated, first concentrating on a mill and then on supporting facilities.... Furthermore the combined pressure from three or more division managers may have reduced the corporation's ability to secure support for diversification.⁶⁸

These non-explicitly accounted for divisional interactions belie a true Stage III.

Performance measures in the paper industry are much more like those of a Stage II firm; that is, cost, market share, and comparison with other firms in the industry. Even in most really diversified firms, the paper segment has a "commitment to the paper industry" which carries through to top management. This allows divisional goals to be set in terms of marginally better ROI than the industry, market share maintenance, or capital expenditures based on providing lower cost than competitors. Research is directed almost completely toward process improvement, rather than new products. Orientation is toward process rather than market development.

CHAPTER V: FINANCIAL AND TECHNICAL CHARACTERISTICS OF SELECTED SUB-INDUSTRIES

This chapter describes the four industry sectors selected for in-depth study and presents pro forma balance sheet and income statement data for new virgin and secondary fiber based mills of "generally recognized" efficient size. The chapter also characterizes differences among the segments, within the context of Chapter IV, and relates them to the industry as a whole.

The segments selected for analysis are linerboard, corrugating medium, folding boxboard, and tissue. Unfortunately, the overcapacity situation in tissue during the field work for this paper has meant that pro forma figures for new tissue mills were not available. Table V-1 presents each sector's percentage of total production and total waste paper use. Tables V-2 and Appendix XXXII present further breakdown.

Selection of sub-industries for detailed study was limited by time and monetary constraints. It is felt that those selected offer a sufficient range of characteristics to be informative and representative. They encompass sulphite (tissue), and kraft (linerboard), and neutral sulfite semi-chemical (NSSC medium), virgin pulps and the full range of waste pulping processes. They include the industry's highest-priced, most marketed product, tissue; the basic commodity items, linerboard and medium; and boxboard. All are areas where recycling could increase from a technological standpoint.

Four other major areas could be analyzed if time and money constraints were not significant. These areas and their percent of 1971 production are:

News and uncoated Groundwood	8.2
Printing, Writing & Related, (except above)	18.2
Packaging & Industrial Converting	9.9
Construction Board	9.1

News economically favors recycling if Garden State's current investments in newsprint plant using its recycling

Table V-1. SELECTED SUB-INDUSTRIES

	Percent of all Paper and Board Production ^a	Percent of all Waste Paper Consumption in Paper and Board
Tissue	7	8.6 ^b
Linerboard (unbleached)	21	5.9 ^c
Corrugating Medium	8.3	11.1 ^c
Folding Boxboard	7.4	27.5-41 ^d

Source:

^a Author's calculations based on 1971 Census figures.

^b Calculated from American Paper Institute. "Paper, Paperboard, and Wood Pulp Capacity 1971-1974," p. 22. Includes waste use in "virgin" board.

^c From Table V-2. Includes waste use in "virgin" board, these are McClenahan's 1969 figures.

^d The larger figure is McClenahan's 1969 figure and includes chipboard. The lower is from Midwest Research Institute, op. cit. p. 78.

Table V-2. PAPER STOCK USED IN PAPERBOARD, 1969,^a AS PERCENT OF PRODUCTION

	Combination Boxboard and Chipboard ^b	Combination Linerboard	Bogus Corrugating Medium	Kraft Liner and Boxboard	Semichemical Grades	Food Boards	Tube, Can & Drum	Gypsum Liner- board	Miscellaneous Paperboard	Total in Paperboard
Mixed	32.6	9.0	1.3	1.7	1.3	-	14.5	23.8	0.6	7.0
News	25.9	-	0.7	-	-	0.1	15.8	24.3	0.2	5.5
Container	35.0	95.0	68.3	16.3	17.5	-	47.6	44.0	2.1	15.7
Pulp Sub- stitutes	17.2	4.2	0.1	2.1	0.1	0.6	9.7	13.9	0.1	3.8
Deinking	4.7	0.3	0.2	-	-	0.3	0.5	0.6	-	0.8
Total	115.4	108.5	70.6	20.1	18.9	1.0	88.1	106.6	3.0	32.8
1 of U.S. total paper stock con- sumption	41.5	3.7	5.5	2.2	5.6	0.1	5.4	7.5	0.2	71.7

Source: Percentages calculated from data in McClenahan "Consumption of Paper Stock in U.S. Mills in 1969 and 1970,"
percentages are waste input into production i production. Percentages higher than 100 percent result
principally from inaccuracies in McClenahan's survey and estimates as well as from process losses.

^aEnd use allocations partially estimated, especially for boxboard, chipboard, containerboard and medium.
^bIncluding container chipboard.

process are a reasonable prima facie case. Like the other grades studied, a recycled news mill is much less capital intensive than its virgin counterpart. Printing and related is a very diverse segment with some strong similarities to tissue: 1) wide variation in actual current production quality with Midwest Research Institute's conclusion that nothing definitive can be said in general about quality differences between virgin and recycle;² and 2) quality and production characteristics depend to a large extent on high grade pulp substitutes and those secondary grades most in demand. Packaging and industrial converting is in large part kraft bag paper and thus somewhat similar in industry characteristics to kraft linerboard, including the strength/weight consideration in marketing. Construction board is an interesting recycler, but beyond the scope of this study.

The sections that follow will not concentrate on technical comparisons of recycle versus virgin fiber in the industries under discussion. For the most part, such comparisons are inconclusive since the range of measurement parameters is so broad. Further, the data and opinions concerning such comparisons tend to be based on existing and, in the case of secondary fiber, relatively diverse or company engineered installations. Secondary fiber technology as practiced is not as technically generalizable as virgin systems. For a discussion of current industry "feel" for these topics the reader is referred enthusiastically to Paper Recycling: The Art of the Possible by the Midwest Research Institute.³ The major reasons this report can escape the dilemma of technical characteristic comparison are twofold. Principally, our models are income statement, rather than cost models. Thus, we assume the market place adequately discounts any technical product differences. Secondly, the complexity, non-availability, and equivocal nature of data on the properties of secondary based products from pro forma optimal plants place an extended technical product comparison outside the character of this dissertation.

First, we shall present some background economic data on all the sectors to add to the contextual framework of Chapter IV. It should be noted, however, that the industry character developed in Chapters IV and VI far overshadows the minor differences this chapter discusses. Background economic data concerning the current position

of the sub-industries, as contrasted to pro forma data, will be found in Appendices XXXIII to XXXIV, XXXXVIII, and LVI. Much of this data may be compared (but only by the very interested reader) to that of Appendix XXIX. Briefly, Appendices XXXIII to XXXV show the descending median size of pulp mills as follows: kraft, NSSC, sulphite, and de-ink. Appendices XXXVI to XXXVIII show current sizes for tissue and board mills. Other appendices present selected data within the set of appendices devoted to each sub-industry.

Tissue

Tissue of one of the highest prices paper products, as reflected in Appendix XXXIX, showing a high value added per production worker. Appendices XXXX to XXXXII indicate the unique character of tissue in being significantly more concentrated than the industry at both the primary and converting stages. Table V-3, illustrating significant integration at the converting stage, reflects tissue's oligopolistic market, low weight/volume ratio (implying pressure to minimize transportation in intermediate stages), and delicacy of stock. Appendix XXXXIV illustrates inputs to tissue production. The significant factor is the wide variety of pulp types. Tissue is, in practice, a very flexible product despite the fact that it must travel at 2000 feet per minute on the dryers. But, due to the thinness of the sheet and its high speed, contaminants are an especially critical variable.

In "Secondary Fiber Problems in a Tissue Mill" David Clark sums up the problems in using PCW, such as magazines and ledger, in tissue production as being contaminants and communication.⁴ Communication refers to the importance of the relationship with the supplier. The mill must rely on its supplier to know his sources and take corrective action should any contaminant problems arise.

Garden State, the recycle news manufacturer, has often been noted for its supply quality by executives faced with contaminant problems, such as our Consumer Products tissue company to be discussed in Chapter VI. Garden State works through brokers, specifying an upgraded #1 news excluding potential contaminants.⁵ These brokers work through small dealers to make sure quality requirements are met.⁶ The brokers spend time in the mill checking the quality of the paper they ship, each small dealer's paper being individually identified. We should emphasize that this scenario is for news, a low

Table V-3. PERCENT OF PAPER INPUT TO TISSUE (SIC 2647)
PRODUCTION THAT IS MARKET VS. CAPTIVE ^a

Market as a Percent of Total Paper Input		
	<u>Tons</u>	<u>Cost</u>
1963	5.3	6.5
1967	8.0	10.1

^a Source: Calculated from Bureau of the Census data. 1967 Census of Manufactures. Summary Statistics, Vol. I, p. 6-70. Coverage ratio is 96% in 1967, General Summary, p. 33.

quality paper.

The result of contamination worries is that most secondary fiber inputs to tissue production are high grade pulp substitutes and deinking, as shown in Table V-4. This waste is generally high priced, in short supply, and prompt. The use of prompt waste is common because it guarantees quality and quantity. Normally, a tissue mill will contract to purchase all the waste from a converting plant. This waste might be the prompt from converting, like envelope or milk carton cuttings, or PCW like the paper to which vinyl for car tops adheres before being affixed to the vehicle. In both cases, quality is known and quantity relatively predictable. Although contracts with such sources may be verbal and only one year in length (short relative to virgin source guarantees), they are excellent by waste source standards. This is for two reasons: the source tends to be a business with which the paper firm relates (perhaps it is "converting" the paper firm's products, or at least is "acceptable" in the terms of social context); and the paper firm is likely to be, or consider itself to be, the only current competitive outlet for this scrap. The latter point may pertain because of a long standing relationship or because the paper firm has established an operation based on a particular waste source, such as polycoated milk bottles, or the vinyl top paper. These factors account for the opinions of two tissue firms in this author's research: 1) the only waste sources which are acceptable in price, since pulp substitutes are in high demand, are unique, inelastic supply situations we have developed; and 2) the use of low-grade waste paper, for instance de-inked news to replace groundwood pulp, would represent entering a new business.

If there are appropriate summary comments concerning tissue, they would stress the great diversity of this sub-industry, which, although concentrated and oligopolistic, encompasses many specialty mills and 100 percent recycle mills.

Analytical Framework

Before presenting income and balance sheet information for linerboard, corrugating medium, and folding boxboard, it is appropriate to outline the format of analytical presentation and the derivation mechanisms.

Table V-4. WASTE PAPER INPUTS TO TISSUE
STOCK PRODUCTION BY GRADE, 1969^a

	Percent
Mixed	0.2
News	3.9
Container	6.4
Pulp Substitutes	53.3
Deinking	36.1

^aSource: McClenahan, "Consumption of Paper Stock by U.S. Mills in 1969 and 1970." Percentages calculated by author. Tissue represented 8% of total U.S. paper stock consumption in 1969.

Table V-5 presents the format this paper adopts to illuminate balance sheet and income statement data. All figures are pro forma for new plants. Plant size is a "generally recognized" efficient size (see Chapter VI for an expansion of this point). Investment figures are generally from one source for each model, although there essentially is industry agreement on magnitude. Where company names are sourced, Table VI-1 can provide a characterization of specific firms. For this chapter the only significant point concerns the small size of the sample for specific data points, with only magnitudes checked against industry norms. Clearly this is a function of time, money and industry cooperation. That is, where a firm provided detailed data, those figures were used as long as they appeared generally in line with the industry.

During the following discussion, the reader may wish to refer to Appendix XXXXV, which presents the detailed data derivation for combination linerboard. This is similar in format to the detailed derivations for other products presented in later appendices.

Investment data is broken down by year for three years prior to the first operating year, 1, and by plant, equipment and land. Except for dry-formed boxboard, land was assumed to cost \$1 million, a generally agreed upon industry figure. For purposes of calculation, land is included in working capital, which is invested at the end of the last year prior to first operation and paid back at the end of plant life. Data from Imperial and Midwest Box yielded working capital of 6 percent of net sales in a normal year for a recycling facility and 6.9 percent for a virgin operation, reflecting larger virgin inventories. Working capital was assumed to remain the same at various levels of below-capacity operation.

A computer program "Grant" (using the BASIC computer language), which appears in Appendix XXXXVI, was written for the income statement calculations. The program computes cash flows (all flows occurring at year end) for 40 operating years and three years prior to operation. (Plant and equipment were assumed to have an actual life of 40 years.) Several different return figures are calculated based on these cash flows.

Sales dollars are calculated from representative prices

Table V- 5. FORMAT FOR PRO FORMA BALANCE SHEET AND
INCOME STATEMENT DATA^a

Product Manufactured

Size of Plant (tons of production per day)

Investment (land, plant, and equipment)

Normal Year Income Statement Data

Sales, less freight out

Fiber furnish, plus freight in

Conversion

Variable, including chemicals

Fixed, excluding depreciation

Selling, General, and Administrative

<u>Tax and Depreciation Method</u>	<u>Cash flow internal rate of Return (%)</u>	<u>Payback (yrs)</u>	<u>5 year return on net assets (%)</u>
before tax, straight line			
after tax, straight line			
after tax, accelerated			
after tax, accelerated, 7% investment tax credit			

^aSource: Resource Planning Institute.

for the New York/Chicago areas as of the end of August, 1973, obtained from Fred Shering, editor, Official Board Markets. Freight out is the midpoint of sample firm estimates. Normal year sales and variable costs are based on production noted under plant size. First year sales and variable costs are 86 percent of normal (Imperial's estimate) to reflect the start-up situation.

Fiber furnish for virgin fiber is based on Big Box's current purchase costs adjusted for fiber type, since other firms use book cost. For secondary fiber, the furnish mix was obtained from the firm studied, consulting reports, or technical articles as noted. Prices were taken as a reasonable average of the New York/Chicago price ranges. Freight in is estimated from sample firm data or cited consulting reports.

Although price controls were in effect when sales and input prices were measured, we believe these prices are a better approximation of the future than any average of earlier prices.

Conversion costs are from the specific firm providing data or from explicit assumptions based on averages of data from other firms or consulting reports, where noted.

Selling, general and administrative expenses were taken as 8.2 percent of gross normal years sales. This figure reflects corporate overhead; plant administration is considered a fixed conversion cost. The 8.2 percent was derived as follows: 11 percent is the average S, G + A for 1966-1971 as reported to the Internal Revenue Service for all paper companies and as appearing in American Paper Institute's, The Statistics of Paper, 1972. Midwest Box and Imperial have in-plant fixed selling, general, and administrative (S, G + A) charges which average 2.8 percent of gross sales. Subtracting this, we have 8.2 percent as a reasonable corporate overhead charge. Many firms do not include this when computing pro forma returns. S, G, + A is assumed to remain the same for different levels of below capacity operation and for changes in sales price during sensitivity analysis.

Three rates of return are calculated: cash flow internal rate of return, payback, and 5-year return on net assets. Cash flow IRR is that rate of discount which makes the present value of inflows equal to the present

value of outflows. It is calculated over the 43-year cash flow period. Payback is the round number of years necessary for the cash flow to return the plant and equipment investment, measured from the end of the last year before operation, and thus is more favorable than IRR. Payback is the least meaningful return calculation from a theoretical viewpoint, but is a common industry yardstick. Five-year RONA, or return on net assets, a concept commonly employed by paper firms, is computed as follows:

$$\frac{\text{cashflow in operating years 1, 2, 3, 4, 5}}{5}$$

$$\text{plant} + \text{equipment} + \text{W.C.} - \left[\frac{5}{2} \frac{\text{Plant Invest.}}{\text{Plant Life}} + \frac{\text{Equipment Invest.}}{\text{Equipment Life}} \right]$$

Returns are computed under a number of different assumptions. Without special subsidies, depreciable life of plant is taken as 40 years and of equipment 16 years. The income tax rate is taken as 47 percent, the weighted average tax rate computed by this author from Internal Revenue Service data for all SIC 26 firms in the period 1950-1969. Accelerated depreciation, based on sum of the year's digits method, is used. The investment tax credit is taken as a cash flow in the year received, which assumes enough corporate income to utilize the tax credit.

The analysis to be presented should be taken as reasonable, but not definitive. The sample was small for numerical analysis of costs, since emphasis was placed on industry analysis. However, the actual recycling rates in the sub-industries are ordered as predicted from the relative returns of virgin versus secondary fiber in the sub-industries.

Linerboard

Linerboard is the single largest grade in terms of production. It is a standardized commodity with little diversity. Appendix XXXXVII indicates the relatively low value added per production worker at the converting stage. Appendix XXXXIX illustrates the declining percentage of recycle linerboard from 11.7 percent in 1961 to 2.2

percent in 1971. This is largely a result of the innovations in kraft which allow hardwood and wood residues to be pulped, providing impetus for large scale mills in areas where, following World War II, there were ample hardwood forests remaining.

Secondary fiber for "combination" linerboard, principally old corrugated and clippings as per Table V-2, does not suffer from as critical contamination problems as tissue, although adhesive tapes can be a problem. But, secondary fiber produces lower mullen or burst strength for a given weight, potentially a significant disadvantage for shipping containers. Arthur Claghorn notes that secondary fiber used in linerboard provides these characteristics:⁷

- . denser sheet at same price levels;
- . lower vapor transmission;
- . superior stiffness; and
- . better holdout of oil type printing and viscous coatings.

These differences are accounted for in our models through the use of market prices for virgin and secondary.

Pro forma income statement and balance sheet data for virgin and secondary based linerboard are shown in Tables V-6 and V-7. Back-up data is in Appendices XXXV and L. The figures indicate after tax returns of 4.3 percent and 9.1 percent for recycle and virgin, respectively. Table V-8 underlines the importance of operating rates for both recycle and virgin mills by illustrating the change in return with operating rates. Virgin still maintains its advantage as fiber cost increases. With a 50 percent fiber cost increase, not unlikely from an historical standpoint for secondary fiber, the virgin system is still profitable while recycling goes into the red. As sales prices increase, however, only the absolute return difference remains similar, with the percentage difference less favorable to virgin than at present. Thus, we conclude recycling will remain at a significant disadvantage.

It should be noted that Arthur D. Little indicates development of a new process which separates linerboard

Table V-6. PRO FORMA BALANCE SHEET AND INCOME STATEMENT
DATA FOR SECONDARY BASED LINERBOARD^a

Product: 42 lb/1000 sq. ft. combination linerboard
Size: 450 tpd
Investment: \$44,400,000 plus W.C.

Normal Year Income Statement Data

Sales, less freight out	\$19,023,840
Fiber furnish, plus freight in	
Base Stock	5,239,904
Top Liner	3,209,300
Conversion	
Variable, incl. chem.	4,404,767
Fixed (excl. dep.)	1,269,782
S, G & A	2,092,622

	IRR (%)	Payback (yrs)	5 yr. RONA (%)
b.t. straight line	5.4	16	7
a.t. straight line	3.7	19	6.4
a.t. accelerated	3.9	18	8.2
a.t. accelerated, 7% ITC	4.3	18	9.3

^a Source: Resource Planning Institute. Reference Appendix
XXXV.

Table V-7. PRO FORMA BALANCE SHEET AND INCOME STATEMENT
DATA FOR VIRGIN NATURAL LINERBOARD^a

Product: 42 lb/MSF virgin natural linerboard

Size: 1000 tpd, 350,000 tpy

Investment: \$106,000,000 + W.C.

Normal Year Income Statement Data

Sales, less freight out	\$46,200,000
Fiber Furnish	15,750,000
Conversion	
Variable, incl. chem.	9,160,200
Fixed (excl. dep)	4,590,000
S, G & A	4,161,000

	IRR (%)	Payback (yrs)	5 yr. RONA (%)
b.t. straight line dep.	11.7	8	14.9
a.t. straight line dep.	7.9	11	10.5
a.t. accelerated depr.	8.3	10	12.4
a.t. accelerated, 7% ITC	9.1	10	13.4

^aSource: Resource Planning Institute. Reference Appendix
XXXXVII.

Table V-8. SENSITIVITY ANALYSIS COMPARISON OF VIRGIN
LINERBOARD WITH RECYCLE LINERBOARD ^{a, b}

Variable	IRR		Payback	
	Recycled	Virgin	Recycle	Virgin
Sales Price				
25% less	(-)	(-)	(-)	(-)
25% greater	11.4	13.1	8	7
50% greater	16.8	21	6	5
100% greater	26.6	30.6	4	3
Fiber Cost				
50% less	10.5	13.1	9	7
50% greater	(-)	3	(-)	22
100% greater	(-)	(-)	(-)	(-)
Operating Rate				
86% capacity	2.4	7.0	25	12
91%	3.3	7.7	21	11
96%	3.9	8.3	19	11
100%	4.3	9.1	18	10

^a Source: Resource Planning Institute.

^b Figures are after tax, with accelerated depreciation and
7 % investment tax credit.

from corrugating medium in corrugated boxes, allowing recycled linerboard to offer similar properties to virgin. Under ideal conditions, this process returns 13.2 percent on assets before taxes.⁸

Corrugating Medium

Corrugating medium is the companion product to linerboard. The percentage of medium classified as recycle ("bogus") is shown in Appendix LI to have declined only slightly in the last decade to about 19 percent. All medium uses some waste for performance characteristics, so Bureau of the Census figures refer to medium with less than 25 percent waste as virgin. As Table V-2 indicates, the waste typically used is old containers or container cuttings.

Although the strength/weight ratio is a problem in medium as in linerboard, recycled medium does have some advantages over the short-fibered hardwood semi-chemical (NSSC) virgin pulp:

- . significantly less pollution since only the kraft process is an efficient recycler of its own chemicals;
- . sheet is less brittle on the corrugator;⁹
- . greater wet tensile strength.¹⁰

Tables V-9 and V-10 present income statement and balance sheet data for recycling and virgin corrugating medium. Back-up data is contained in Appendices LII and LIII. They indicate internal rate of return of 7.5 percent and 11.3 percent for recycle and virgin, respectively. Table V-11 shows the importance of operating rate for both recycle and virgin by illustrating changes in the rate of return with operating rate. A fascinating note from Table V-11 is that as sales prices rise recycled board becomes fully competitive with virgin. Modifying this theoretical result, however, is the greater volatility of secondary fiber costs. Since much virgin is costed at book, in a very strong market secondary fiber prices might be expected to rise faster and keep recycling at a disadvantage. Thus, it seems reasonable that recycling of medium will remain

Table V-9. PRO FORMA BALANCE SHEET AND INCOME STATEMENT DATA
FOR COMBINATION (BOGUS) CORRUGATING MEDIUM^a

Product: 26 lb/MSF bogus medium

Size: 300 tpd, 105,000 tpy

Investment: \$19,908,000 + W.C.

Normal Year Income Statement Data

Sales, less freight cost	13,698,000
Fiber Furnish	4,939,000
Conversion	
Variable, incl. chem.	4,108,000
Fixed, excl. dep.	1,118,000
S, G & A	1,192,000

	IRR (%)	Payback (yrs)	5 yr. RONA (%)
b.t. straight line	10.7	9	12.8
a.t. straight line	6.9	13	8.6
a.t. accelerated	7.3	12	10.0
a.t. accelerated	7.5	12	10.4

^aSource: Resource Planning Institute. Reference Appendix LII.

Table V-10. PRO FORMA BALANCE SHEET AND INCOME STATEMENT
DATA FOR VIRGIN CORRUGATING MEDIUM ^a

Product: 26 lb/MSF NSSC medium

Mill Size: 650 tpd, 350 dpy = 277,500 tpy

Investment: \$54,000,000 + W.C.

Normal Year Income Statement

Sales, less freight out	28,892,500
Fiber Furnish	7,052,500
Conversion	
Variable, incl. chem.	7,305,000
Fixed, excl. depr.	2,097,700
S, G & A	2,612,000

	IRR (%)	Payback (yrs)	5 yr. RONA (%)
b.t. straight line	15.4	6	20.0
a.t. straight line	10.2	9	13.2
a.t. accelerated	10.8	8	15.0
a.t. accelerated, 7% ITC	11.3	8	15.9

^aSource: Resource Planning Institute. Reference Appendix LIII.

Table V-11. SENSITIVITY ANALYSIS COMPARISON OF VIRGIN
CORRUGATION MEDIUM WITH RECYCLE MEDIUM^{a,b}

Variable	IRR		Payback	
	Recycled	Virgin	Recycle	Virgin
Sales Price				
25% less	(-)	1.4	(-)	31
25% greater	18.9	17	5	6
50% greater	23.8	23.8	4	4
100% greater	35.7	34	3	3
Fiber Cost				
50% less	13	14.4	7	7
50% greater	(-)	7.7	(-)	11
100% greater	(-)	3	(-)	22
Operating Rate				
86% capacity	5.6	9.5	15	10
91%	6.3	10.1	13	9
96%	6.9	10.8	12	9
100%	7.5	11.3	12	8

^a Source:

^b Figures are after tax, with accelerated depreciation and
7% investment tax credit.

uncompetitive in the future on a straight return basis.

Folding Boxboard

Combination boxboard's declining share of market from 83 percent in 1961 to 65 percent in 1970 is illustrated in Appendix LIV. This is a result of several factors: ¹¹

- . unfavorable strength/weight ratio in lower calipers;
- . gray-back aesthetics;
- . economics of the cylinder machine (the older method of forming); and
- . contamination problems in food packaging.

Recycled fiber presents some advantages, however, including a better printing and adhesive surface. ¹²

Tables V-12 to V-14 present data on virgin and recycle boxboard mills in the .016-.018 caliper range (full data is in Appendices LVII to LIX). They indicate that a modern recycle boxboard mill generates a higher cash flow internal rate of return even at the lower calipers than a virgin mill, 16.6 percent and 31.3 percent IRR's versus 12.5 percent. In these tables clay coated newsback (dark back) is compared with a bleached (white front and back) virgin box. The virgin box is .002 caliper more narrow in order to have comparable products from an end use standpoint. ¹³ This strength/weight discrepancy and any aesthetic considerations are assumed to be adequately reflected in the market prices. The ultraformer used in the model is a relatively new, but proven, paper machine superior to the older, more common cylinder machine. The dry-forming process is an Arthur D. Little experimental system and financial results should be viewed as such.

Table V-15 illustrates that ultra-former .018 caliper folding boxboard increases its advantage over virgin as sales prices rise but compares unfavorably as sales price decreases or fiber costs rise. It seems reasonable from Table V-15 to draw the conclusion that secondary fiber will be more competitive in the environ-

Table V-12. PRO FORMA BALANCE SHEET AND INCOME STATEMENT
DATA FOR COMBINATION FOLDING BOXBOARD .018 CALIPER ^a

Product: Recycle Boxboard; Clay Coated Newsback, .018
caliper, 80B, Ultraformer paper machine,
27.2 MSF/ton

Size: 500 tpd; 350 dpy; 175,000 tpy

Investment: \$38,500,000 + W.C.

Normal Year Income Statement Data

Sales, less freight out	\$35,252,000
Fiber Furnish	7,880,000
Conversion	
Variable, incl. chem.	10,841,000
Fixed, excl. dep.	2,432,000
S,G & A	3,005,000

	IRR (%)	Payback (yrs)	5 yr. RONA (%)
b.t. straight line	23.4	4	32.4
a.t. straight line	15.3	6	19.9
a.t. accelerated	15.9	6	21.7
a.t. accelerated, 7% ITC	16.6	6	22.7

^aSource: Resource Planning Institute. Reference Appendix
LVII.

Table V-13. PRO FORMA BALANCE SHEET AND INCOME STATEMENT DATA
FOR DRY-FORMED COMBINATION BOXBOARD^a

Product: Clay Coated Newsback, .018 caliper, dry formed
(Arthur D. Little Experimental Design)

Size: 35 tpd, 330 dpy = .11,500 tpy

Investment: \$1,964,000

Normal Year Income Statement Data

Sales, less freight out	2,374,000
Fiber Furnish	445,000
Conversion	
Variable, incl. chemical	529,000
Fixed, excl. dep.	123,000
S, G & A	198,000

	IRR (%)	Paybacks (yrs)	5 yr. RONA (%)
b.t. straight line	46.9	2	61.4
a.t. straight line	28.7	4	35.4
a.t. accelerated	29.8	4	37.4
a.t. accelerated, 7% ITC	31.3	4	38.6

^aSource: Resource Planning Institute. Reference Appendix LVIII.

Table V-14. PRO FORMA BALANCE SHEET AND INCOME STATEMENT
DATA FOR VIRGIN BOXBOARD .016 CALIPER^a

Product: Solid Bleached Sulphate; 80 Brightness; .016
caliper; 27.84 MSF/ton

Size: 500 tpd; 350 dpy; 175,000 tpy

Investment: \$94,750,000 + W.C.

Normal Year Income Statement Data

Sales, less freight out	\$47,420,000
Fiber Furnish	7,875,000
Conversion	
Variable, incl. chem.	12,085,000
Fixed, excl. dep.	3,562,000
S,G & A	4,075,000

	IRR (%)	Payback (yrs)	5 yr. RONA (%)
b.t. straight line	17.7	5	23.25
a.t. straight line	11.7	8	14.9
a.t. accelerated	12.2	7	16.8
a.t. accelerated, 7% ITC	12.5	7	17.4

^aSource: Resource Planning Institute. Reference Appendix LIX.

Table V-15. SENSITIVITY ANALYSIS COMPARISON OF .016 CALIPER
FOLDING BOXBOARD WITH .018 CALIPER RECYCLE
BOXBOARD, BOTH ULTRAFORMER AND
ARTHUR D. LITTLE
EXPERIMENTAL DRY-FORMED PROCESSES^{a, b}

Variable	IRR			Payback		
	Recycle		Virgin	Recycle		Virgin
	Ultra Former	Dry-Formed		Ultra Former	Dry-Formed	
<u>Sales Price</u>						
25% less	3.1	16	5.1	22	7	15
25% greater	26.2	45	18.4	4	3	5
50% greater	34.5	57.8	23.5	3	2	4
100% greater	48.8	81.3	32.7	2	1.3	3
<u>Fiber Cost</u>						
50% less	20.5	36.4	14.5	5	3	6
50% greater	12.4	26.3	10.5	8	4	9
100% greater	7.4	21.2	8.2	12	5	11
<u>Operating Rate</u>						
86% capacity	14.2	27.8	10.7	7	4	8
91%	15.1	28.9	11.4	6	4	8
96%	16	30.2	12	6	4	8
100%	16.6	31.3	12.5	6	4	7

^aSource: Resource Planning Institute.

^bFigures are after tax, with accelerated depreciation and
7% investment tax credit.

ment of the future since the fiber cost impact on return differentials is less than that of rising sales price. However, history indicates (as demonstrated in Figure VII-1 and VII-2) that secondary fiber costs may increase 50 percent while virgin costs increase only marginally. With secondary fiber costs up 50 percent, and virgin costs remaining the same, ultraformer boxboard is not competitive with virgin. This cost rise, then, is significant. We may conclude from these figures that recycling in .018 caliper boxboard will be competitive with virgin but not enjoy the large advantage Table V-21 indicates, unless dry-forming becomes a practical reality.

Tables V-16 and V-17 compare virgin and recycle in the higher .022 caliper, showing a very close IRR competition. Back-up data is in Appendices LX and LXI.

Table V-18 reveals a situation similar to .017/.018 caliper boxboard. The processes are currently competitive. At higher sales prices recycled looks much better, but at the corresponding higher fiber costs, recycled looks worse. A logical conclusion is that they will remain fairly competitive in the future.

Summary

In summary, we note that the recycling level is related in the expected way to the return differential between virgin and secondary processes. That is, secondary fiber looks progressively better in terms of differential pro forma return moving from linerboard to medium to folding boxboard; and this is the direction of recycling rates, as illustrated in Table V-19. However, only in boxboard is secondary fiber competitive with virgin for the future.

Table V-16. PRO FORMA BALANCE SHEET AND INCOME STATEMENT
DATA FOR WHITEBACK RECYCLE FOLDING BOXBOARD, .022 CALIPER ^a

Product: .022 Caliper Combination Folding Boxboard,
23.25 MSF/ton
Front: 80B; Back 70B; Ultraformer Paper Machine

Size: 500 tpd; 350 tpd, 175,000 tpy

Investment: 38,500,000 + W.C.

Normal Year Income Statement Data

Sales, less freight out	33,509,000
Fiber Furnish	11,640,000
Conversion	
Variable, incl. chemicals	11,140,000
Fixed, excl. depr.	2,432,000
S,G & A	2,863,000

	IRR (%)	Payback (yrs)	5 yr. RONA (%)
b.t. straight line	12.5	8	15.7
a.t. straight line	8.4	11	11.0
a.t. accelerated	8.9	10	12.8
a.t. accelerated, 7% ITC	9.4	10	13.8

^aSource: Resource Planning Institute. Reference Appendix LX.

Table V-17. PRO FORMA BALANCE SHEET AND INCOME STATEMENT
DATA FOR VIRGIN BOXBOARD .022 CALIPER^a

Product: Solid Bleached Sulphate; .022 caliper;
80B folding boxboard; 21.05 MSF/ton

Size: 500 tpd; 350 dpy; 175,000 tpy

Investment: \$94,750,000 + W.C.

Normal Year Income Statement Data

Sales, less freight out	38,173,000
Fiber Furnish	7,875,000
Conversion	
Variable, incl. chemicals	10,762,000
Fixed, excl. dep.	3,243,000
S,G & A	3,317,000

	IRR (%)	Payback (yrs)	5 yr. RONA (%)
b.t. straight line	12.1	8	15.2
a.t. straight line	8.1	11	10.7
a.t. accelerated	8.6	10	12.5
a.t. accelerated, 7% ITC	9.1	10	13.6

^a Source: Resource Planning Institute. Reference Appendix LXI.

Table V-18. SENSITIVITY ANALYSIS COMPARISON OF .022 CALIPER
VIRGIN FOLDING BOXBOARD WITH .022 CALIPER
ULTRAFORMER RECYCLE BOARD ^{a, b}

Variable	IRR		Payback	
	Recycled	Virgin	Recycle	Virgin
Sales Price				
25% less	(-)	1	(-)	34
25% greater	20	14.5	5	7
50% greater	28.7	18.5	3	5
100% greater	43.3	27.4	2	4
Fiber Cost				
50% less	16.3	11.3	6	8
50% greater	(-)	6.5	(-)	13
100% greater	(-)	3.4	(-)	21
Operating Rate				
86% capacity	7.2	7.5	12	12
91%	7.9	11.8	11	8
96%	8.8	12.5	10	8
100%	9.4	9.1	10	10

^a Source: Resource Planning Institute.

^b Figures are after tax, with accelerated depreciation and 7% investment tax credit.

Table V-19. DIFFERENTIAL PRO FORMA RETURNS FOR RECYCLED
AND VIRGIN PAPER PRODUCTS
COMPARED WITH PERCENT OF TOTAL PRODUCT THAT IS RECYCLED^a

Paper Product	Recycle IRR- Virgin IRR	Recycled Products as a Percent of Total
Linerboard	-4.8%	2.2
Corrugating medium	-3.8%	19.1
Folding boxboard (virgin vs. ultraformer, .016 versus .018 caliper)	.3%	64
Folding boxboard (virgin vs. ultraformer, .022 caliper)	4.1%	

^aSource: Resource Planning Institute. Recycled percentages
are for 1971 and referenced in Appendices
XXXXIX, LI, and LIV.

CHAPTER VI: DECISION CONTEXT IN THE FIRMS STUDIED

The Sample Firms Studied in Depth

The research sample includes two firms in each sub-sector from which financial data was gathered, but we include information on several other firms where appropriate. All the firms examined have mills whose primary input is secondary fiber and mills whose primary input is virgin based. All the firms' paper or board products are related to a vertical chain. The size of this vertical chain's sales as a percentage of sales of the total legal entity ranges from 19 percent to nearly 100 percent. Table VI-1 outlines the companies in our sample (disguised by pseudonym) with relevant paper production data. This may be compared with Appendix LXII to illustrate that our sample is composed of large firms.

The specific sample firms were selected on the basis of judgment by this author to represent the typical large paper firm. The universe of potential sample firms was limited to those willing to discuss the recycling issue in depth and with pro-forma data they would reveal. Within that subset of firms, specific selection was based on: 1) referral by knowledgeable sources, like the American Paper Institute and industry personnel; 2) trade journal articles and annual reports which highlighted firms interested in the recycling issue; 3) trade journal articles referring to potential new mills; and 4) relative interest in the project by the potential sample firm. The degree of rigor in sample firm selection was limited by time and money constraints.

Imperial

Imperial is almost 100 percent a forest products company with sales near \$1 billion. Minor attempts at diversification by acquisition outside the forest products industry have failed, with the new divisions being sold. The company's present product line includes: lumber, kraft pulp, corrugating medium, linerboard, folding boxboard, specialty and bag papers. Imperial is typical of a large non-diversified paper firm.

Table VI-1. SALES BREAKDOWN FOR FIRMS IN SAMPLE^a

Disguised name	Approximate Corporate sales, 1972 (\$ billions)	Integrated paper chain sales as a percent of total corporate sales	Paper Product Line
Imperial	1	93	Lumber, kraft pulp, corrugating medium, linerboard, boxboard, specialty bags
Midwest Box	1	74	Lumber, linerboard, medium, boxboard, printing, specialty
Big Box	1.8	29	Folding boxboard, shipping containers, secondary fiber
Consumer Products	.8	90	Pulp, tissue, printing, specialty, converting
Universal	2	96	Pulp, lumber, linerboard, medium, boxboard, news- print, fine printing
Midwest Packaging	1.5	18	Linerboard, medium, plywood
Eastern Packaging	2	22-60 (not broken down)	Lumber, pulp, folding boxboard, tissue, food packaging, printing

^aSource: Annual Reports. Building materials and lumber considered part of integrated chain. Midwest Box integrated chain sales percentage is for 1971.

Imperial was functionally organized until the late 1950's, with a corporate vice president of manufacturing and one for sales.¹ The acquisition program of the 1950's, involving only forest product companies, provided absorption problems which pushed toward greater decentralization of old-line Imperial businesses at the same time that greater control was exerted over new businesses.² Since many acquisitions of this period were made at least partly for "diversification" purposes, the new businesses were in segments of the paper or board industry unfamiliar to Imperial.

"Beginning in about 1957, a new structure began to evolve characterized initially by the creation or recognition of some 25 operating units all responsible to the president, and culminating six years later in the product group concept with substantial delegation of authority to intermediate levels of management."³

The result is the present organization reflected in Figure VI-1. Imperial's president observed:⁴

The organization has evolved as we sought the best way to manage businesses with common technologies and especially marketing interests. In a sense, we're more centralized now than when 25 division managers reported directly to me; it was difficult to measure and control that many units from a single office even though financial and operating statements were readily available. On the other hand, those managers had a good deal less authority than the Group Vice Presidents do today.

Among the product groups, the old line kraft, bag and printing businesses assume greater importance as a result of higher visibility by senior corporate officers.⁵ It should be noted that although the pulp, paper, and construction products unit sells almost all of its output for later final conversion, either by Imperial or other firms, some of its output is converted paper products.⁶ But, in general, this is the primary product unit, with the other 2 senior V.P. units being converting divisions.

Figure VI-2 illustrates the functional structure of the kraft division. In some of the converting divisions, each mill has salesmen associated with it;⁷ whereas

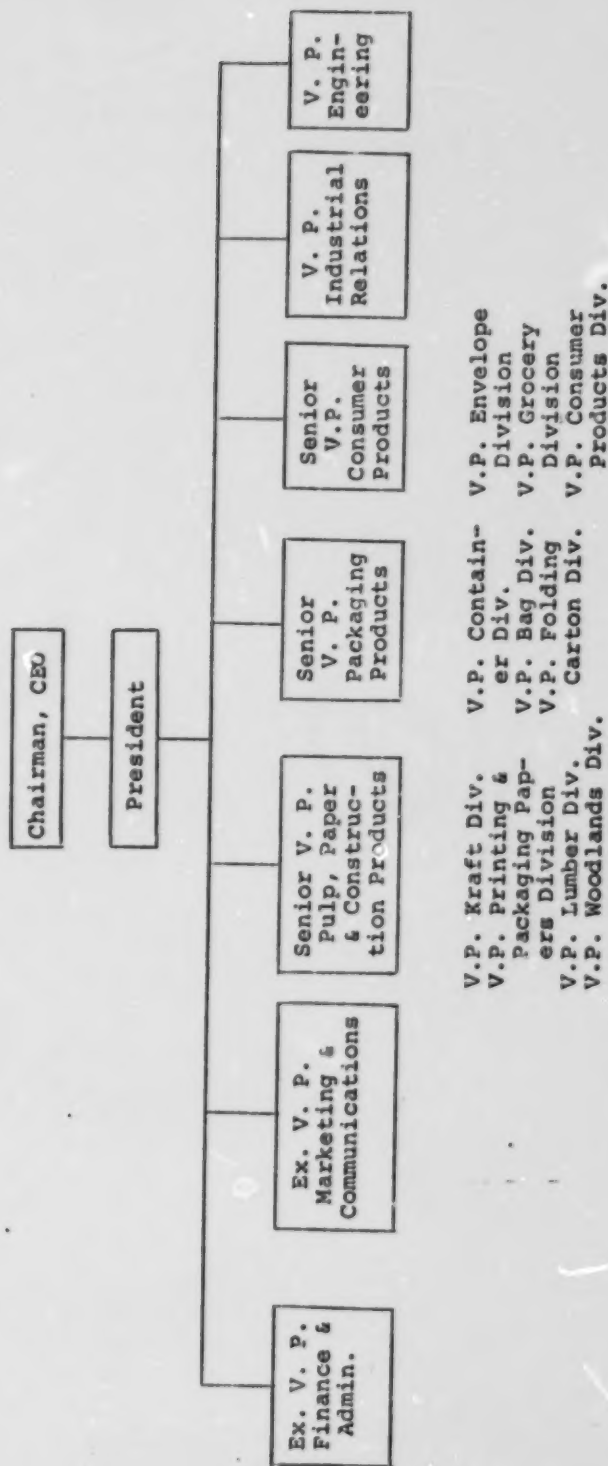


Figure VI-1. Imperial, Domestic Operations, Simplified.

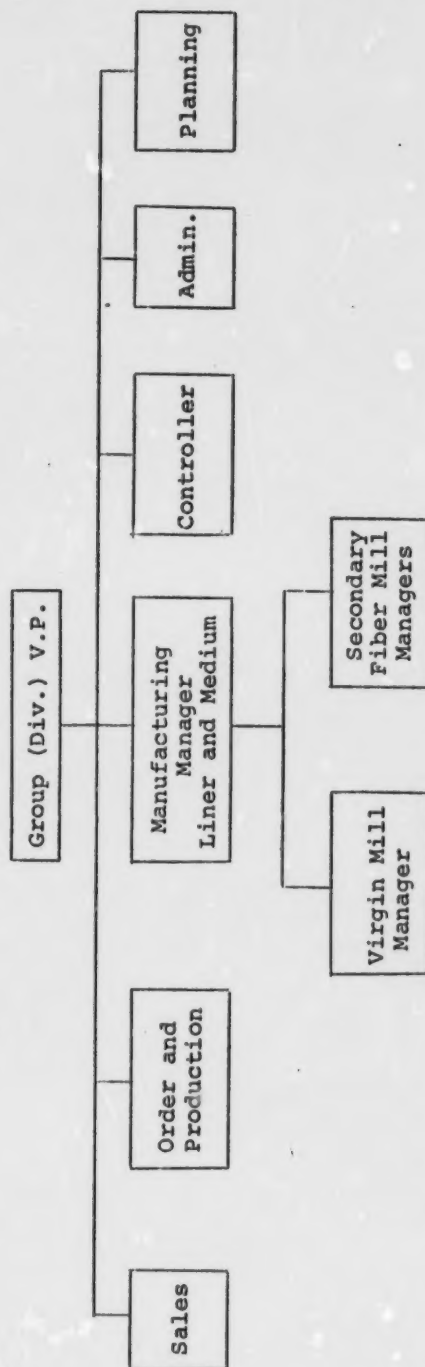


Figure VI-2. Kraft Division Imperial.

production and sales scheduling is done at the division level for the primary products, pulp and board. At division level, production and sales are scheduled for each large mill by computer using differential cost data. This occurs in order to most efficiently utilize input and output by insuring the lowest total cost of input to mills and the most economical sales pattern. From the corporate viewpoint, the most efficient pattern involves careful planning of production, routing on intra-company sales, and inter-company trading for the divisions on both sides of kraft on the integrated chain (woodlands, converting).

Kraft division supplies all the needs of the container division in order to maximize scheduling efficiency and operate the primary processing step as economically as possible. This results in two interesting phenomena: 1) kraft division buys almost as much linerboard outside Imperial as it makes, only to resell it to container division; and 2) the kraft division, virgin in name and heavily so in experience, is responsible for secondary fiber mills. However, smaller mills may be excluded from the division scheduling and allocation scheme; and this is true of secondary mills since they are generally small. Kraft division sells to container division at market prices, so container division "doesn't care"; but the arrangement allows kraft to be sure of sales in excess capacity markets since container division must purchase kraft division output, and container to be sure of input in a good market. The transfer prices involved here are relatively realistic since there is an active market in board, although locational adjustments are made which depart from market; for instance, kraft would give a discount to a container plant located nearby. It should be noted that the ability of kraft division to force its supply on container division implies booking the excess capacity losses of kraft division in container division.

The right of transfer is not spelled out literally since the firm is "product divisionally" organized, but is an implicit company policy perceived as emanating from the board of directors. The Imperial kraft planning manager put it this way: "When boxes are easy to sell, the board of directors would like to have kraft division output go to Imperial converting divisions."

A somewhat similar situation exists for the input to

kraft division. Woodlands division is responsible for supplying all kraft division pulpwood needs despite having to purchase a substantial fraction on the open market. Woodlands division does not supply secondary fiber, presumably because it is too removed from their expertise and because smaller mills are allowed to determine their own input. Transfers from woodlands division have been at cost, but recently an attempt was made to make woodlands division a "profit center." Since market pulpwood represents such a small fraction of the total, and specific location is critical to actual price, the attempt to set a market price for woodlands division transfers is viewed with skepticism by kraft division. As the Imperial kraft planning manager commented to this author, "It is very hard to tell whether these prices are similar to market or not." Thus cost is a major element in Imperial's determination of a market transfer price. Difficulty in determining the best transfer price is compounded by the fact that actual market prices may represent book costs of pulpwood producers, rather than replacement value.

An important point regarding woodlands division is that it owns stumpage but produces no pulpwood. The stumpage is sold to pulpwood producers who guarantee to sell to Imperial. This occurs because:

- . cutters pay lower wages and offer poorer working conditions than Imperial is obliged to provide by obeying OSHA rules precisely; and
- . many small tracts would be uneconomical for Imperial to schedule.

Imperial may assist the pulpwood producers in financing equipment. An Imperial executive, in talking with this author, compared virgin fiber harvesting to paperstock gathering and processing (very bad working conditions) in noting that "most large paper firms that own paperstock dealers don't say so publicly."

Woodlands division does not have the same power over kraft division that kraft has over container. At one point, woodlands wanted kraft to use its excess hardwood, which was cut along with the softwood. (Hardwood may be used up to 11 percent but is regarded by kraft division as a contaminant relative to a 100 percent

softwood kraft pulp.) Kraft division declined because the price didn't make it attractive enough. Imperial's president asked kraft division to take another look, but they will still be able to decline. This pattern, which allows kraft division an input flexibility denied container division, increases booked profits at kraft division.

Midwest Box

Midwest Box is a diversified firm with sales near \$1 billion, with the integrated chain representing 74 percent of sales. The integrated chain includes lumber, linerboard, corrugating, folding boxboard, printing and specialty papers. Figure VI-3 illustrates Midwest's decentralized organization.

Fiber supply, both virgin and secondary, is handled at the mill level. Each virgin mill controls its own wood supply and any transfers between mills are negotiated by the mill managers in the same way inter-firm sales would be. The corporate woodlands office acts only in a consulting capacity. Each mill using secondary fiber makes all the necessary arrangements, although one man in the firm, a knowledgeable individual at one of the recycle mills, gives advice and helps with coordination problems.

The paperboard division is responsible for supplying all container division's needs, even though that may require the purchase of liner or medium outside. All transfers are at market prices.

Evaluation of division presidents' performances are based on comparison against return goals set at Corporate level. These goals take into consideration the industry environment; thus paperboard goals are much lower than those for non-paper industry divisions. The return evaluation is coupled with the long-run corporate decision to remain in or leave each major line of business.

In summary, even though Midwest Box is very decentralized, with each division a profit center, there are critical interdivisional dependencies and a corporate philosophy to maintain a capacity balance along the vertical chain.

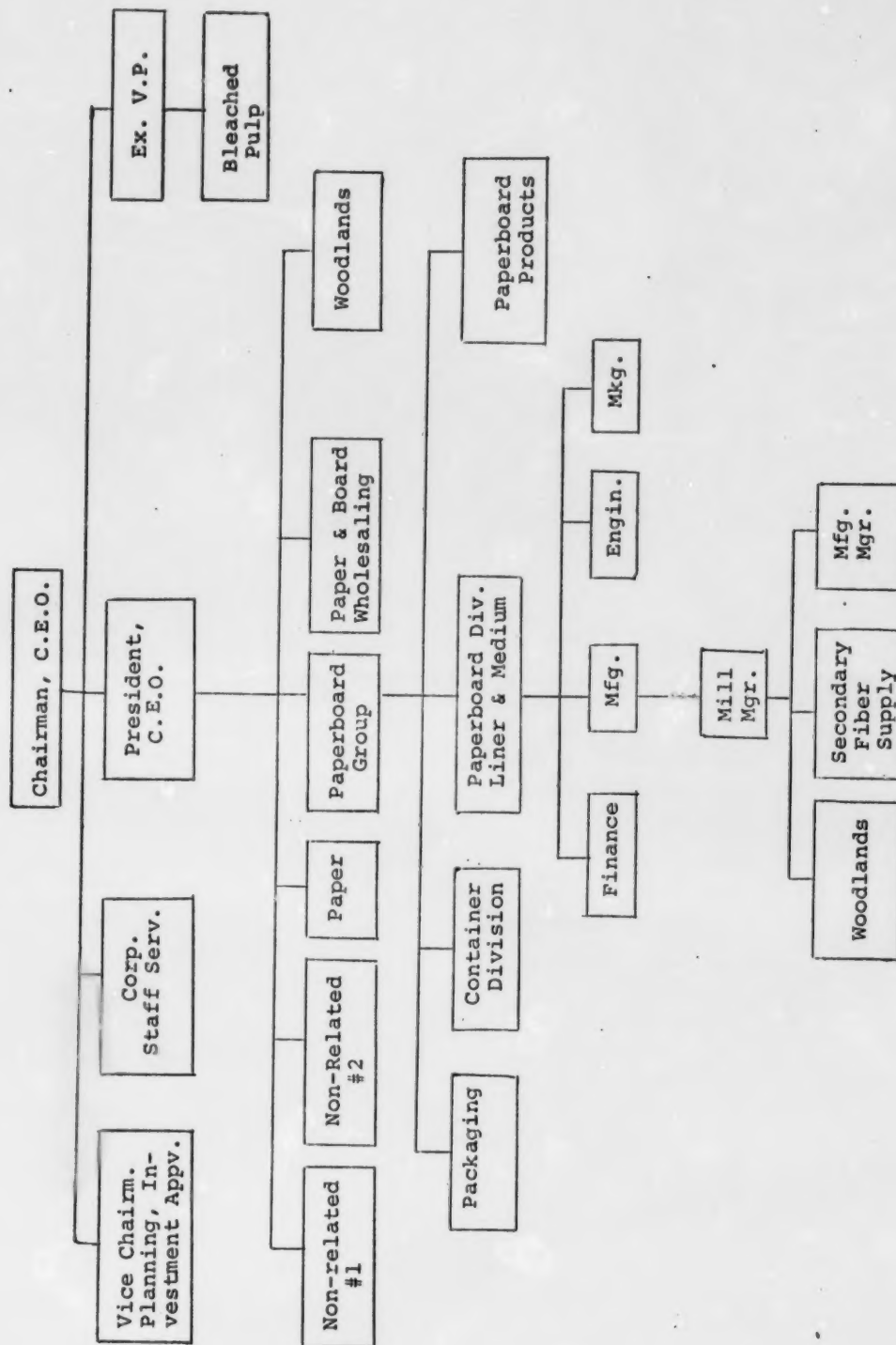


Figure VI-3. Midwest Box, Simplified.

Big Box

Big Box represents about 29 percent of the sales of the holding company which acquired it. Big Box's activities are almost completely related to a vertical chain, as shown in the organizational structure of Figure VI-4. While folding boxboard is the principal product, the line includes shipping containers.

Big Box is unusual for a large paper company in two respects: (1) it is not a major landholder; and (2) it has made a major commitment to the paperstock business. The paperstock division supplies 45 percent of Big Box fiber requirements, while selling 30 percent of its paperstock on the market. Paperstock sources were developed by acquisition, contractual arrangement (perhaps involving equipment financing), and source development (staff calls to supermarket chains).

Big Box's policy is to supply about 80 percent of converting needs from internal sources. This implies that in a period of excess board capacity the primary processing units will run at capacity with converting units at below capacity. This philosophy was described as a primary reason for their high return on investment (ROI) relative to the industry. A Big Box Senior V.P. reflected that some large integrated paper firms were willing to maintain excess primary capacity because: 1) they were more diversified within the paper and board industry; or 2) they utilized waste from lumber operations to provide a low pulpwood transfer price.

Within Big Box, mills are almost 100 percent virgin or 100 percent secondary fiber. Since most folding boxes are made from secondary fiber, the combination board mills are in the same division as boxes and non-related packaging products. Marketing strategy for the folding box division is the improvement of ROI by product differentiation through unique design and custom manufacturing service. Each mill orders all its input internally from Big Box woodlands division or paperstock division, even though these may be in a different group and may have to buy outside to make up total supply. Although designated a profit center, woodlands supplies pulpwood at cost. As a Senior V.P. of Big Box indicated:

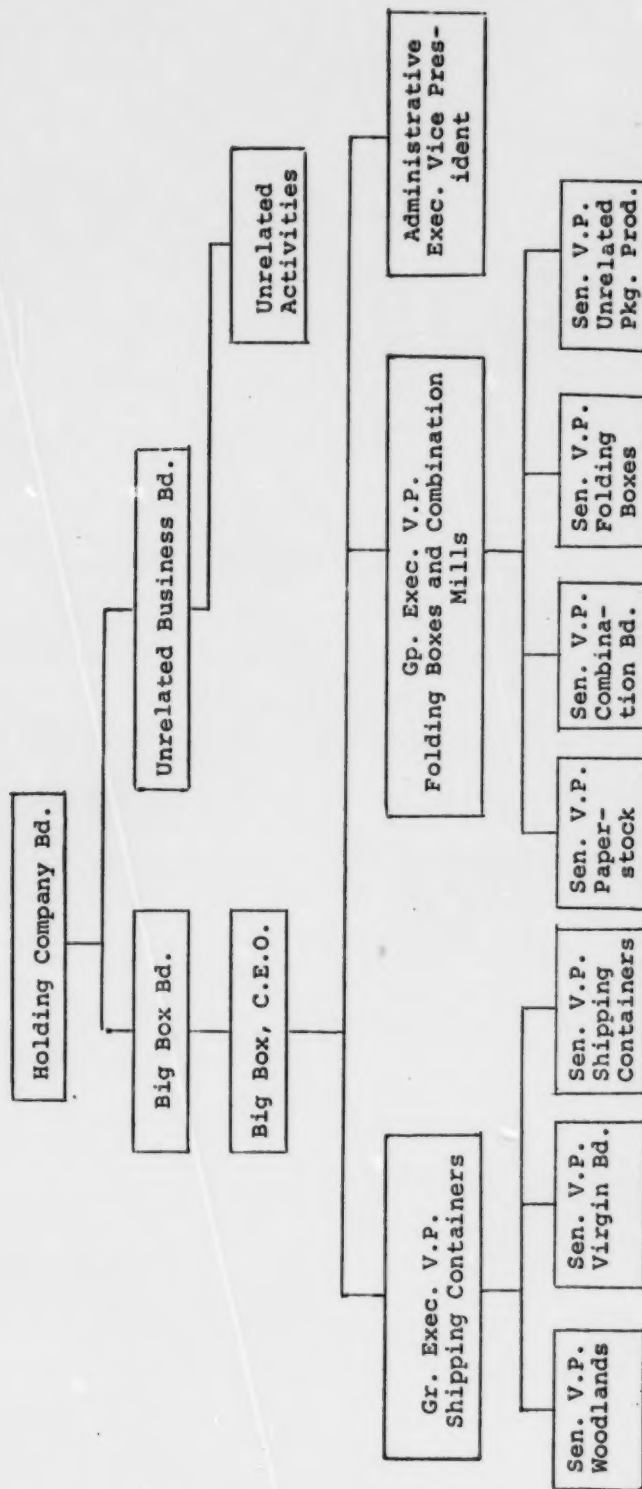


Figure VI-4. Pig Box Simplified.

Woodlands is a profit center that never makes a profit. Even the transfer price revenue doesn't seem to cover costs.

The paperstock division, which supplies all the paperstock needs of container board and boxboard mills, transfers at cost; but the paperstock division is paid \$1/ton commission. This means that in periods of rising raw material prices, Big Box secondary fiber mills enjoy the same advantage its virgin mills do: guaranteed supply at relatively guaranteed prices; although, of course, actual price depends on tightness of control over source. Presently Big Box is integrating backward into both land and paperstock.

Big Box represents a very unusual situation in the paper industry: waste fiber input is handled strategically and structurally in the same manner as virgin is in the other firms (and in Big Box). The importance of Big Box in the recycling field is not a coincidence. At Big Box, the paperstock division:

- . "owns or controls" its supply source;
- . allocates all secondary fiber input centrally;
- . maintains an excess of secondary fiber over current needs.

Thus, at any point in the organization outside the paperstock division, including mill manager, waste supply is organizationally equivalent to virgin supply. The organizational equivalence produces other similarities:

- . stability of supply quantity; and
- . relative stability of supply price and quality.

Board mills transfer to converting facilities at market prices. Although converting mills have the "theoretical right" to buy anywhere (they are "profit" centers), it is an implicit policy that all needs will be purchased through Big Box board plants.

These policies are consistent with incentives strongly based on performance versus a comparable plant and versus the industry. These performance measures indicate

the pervasiveness of the industry climate even within a truly diversified firm.

Consumer Products Co.

Consumer Products, with sales near \$1 billion, is a major firm in the tissue industry. Tissue products represent about 65 percent of sales, with other paper products representing 25 percent. Figure VI-5 illustrates Consumer Products' organizational structure. The divisional organization is a result of changes from a functional structure in the late 1960's. The new organization was aimed at decentralizing decision making by grouping product lines in profit center divisions.

The paper divisions of Consumer Products Co., in the concentrated tissue sub-industry, are very centralized. Although mills are cost centers with performance measured against budget, a linear programming model at division level allocates input and output for each plant manager. Fiber division allocates all virgin fiber input to mills in the packaged products division and the fine paper division, with any purchases or sales of pulp made outside Consumer Co. being handled by the fiber division. All pulp transfers allocated by the fiber division are booked at historical cost.

The Fiber division does not, however, become involved in secondary fiber purchases except in advice-if-requested situations. Each mill using secondary fiber, for all or part of its input, must locate its own sources. The presumption at the corporate level is that these sources will be local because of transportation expenses and the necessity to know the character of the supplier. On the virgin side, each mill has a woodlands manager associated with the forest near the mill. This woodlands manager reports to the corporate woodlands division.

Consumer Products Co. is typical of large firms in the paper industry as a whole in that it produces more pulp than it converts. The philosophy of the fiber division involves the necessity of assuring input for future growth of the converting divisions. Clearly, a commitment to the paper industry is implied, despite recent diversification moves.

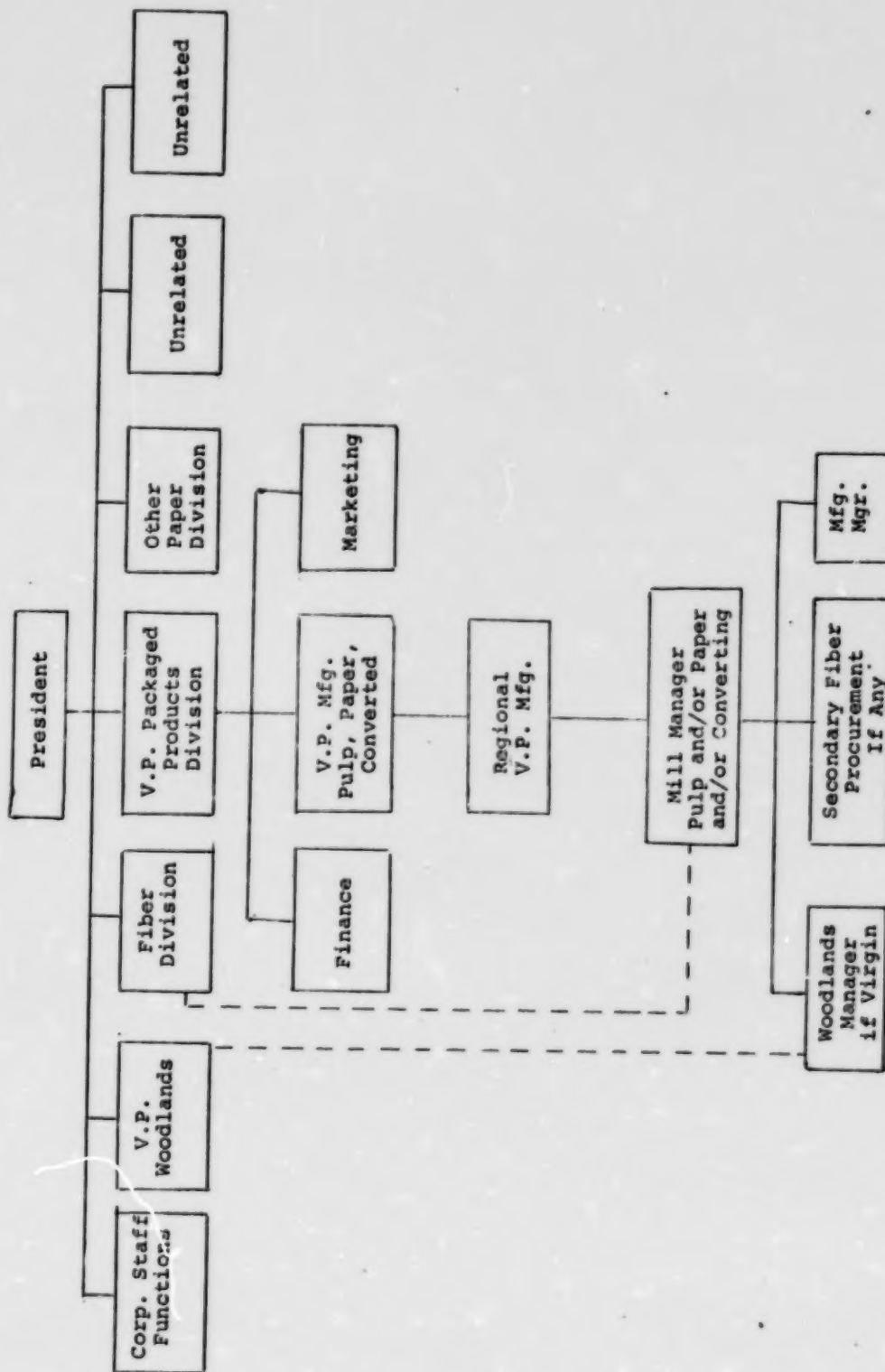


Figure VI-5. Consumer Products Co., Simplified.

The New Mill Decision

Elements

This section discusses the new mill investment process within the context described in Chapter IV, concentrating on pulp, paper and board, questions of recycling aside. It relies heavily on Ackerman's work,⁸ providing additional data from the author's research where appropriate.

A major element in the new mill decision is the size of its impact in monetary terms. A \$100 million investment is significant even for most diversified firms. This implies that whatever formal approval mechanisms exist for quantum step investments, the investment process is sure to be much more complex than a theoretical model of return maximization. Chamberlain summarizes reasons which help explain the complexity of our findings:

Six reasons, then, help to explain why in the field of capital budgeting business practice diverges from economic analysis -- the business belief that judgment is more important than quantification when the basic data are weak, management's setting of a specific and limited profit target rather than a theoretical maximum, the economists' failure to give adequate recognition to the strong business preference for liquidity, the fact that the flow of ideas for new investment is not always so deep and turbulent as to require careful ranking of competing projects, the acquisition based on judgmental factors of those companies as an outlet for investment funds and the internal political pressures which cannot be ignored.⁹

But the usefulness of our conceptual framework is not destroyed since:

None of these reasons, it will be observed, marks a decisive conflict between the theory and the practice of capital budgeting. They deal largely with institutional modifications of the abstract model, lessening its sharpness and precision but leaving it, in broader and blunter outline, still representative of budgeting procedures toward which firms which plan their actions are clearly moving.¹⁰

The research supports an hypothesis stressing the

importance of context, and the inadequacy of pro-forma IRR as a predictor of investment behavior. Ackerman summarizes his experience as well as this author's:

The willingness of a manager to give impetus or commitment to an investment did not appear to be based primarily on the ROI forecasted in the analysis though this measure constituted a constraint or a minimum expectation in most cases. Practically speaking, the decision point tended to occur before the analysis was completed and in a sense rationality was 'bounded' by the vast uncertainties raised in the consideration of a large investment with significant market overtones. Yet, maximization of ROI for individual projects was not the point for most managers responsible for reviewing them as business propositions; instead, an assessment of the discrepancy, the proposed response, and the unit's ability to prosecute the venture were the critical concerns. 11

It seems appropriate to outline in as general terms as possible the factors influencing the new mill decision among all the firms studied.

1. The paper and board segments of all the firms are integrated, implying the pervasive influence of vertical integration on structural context. Many of those characteristics outlined in Chapter IV apply to the paper and board segment even if the corporation as a whole is diversified.

2. "The definition of investments is most strongly influenced by the identification of a discrepancy in the operations of a single operating unit." 12 Whether the pressure is from a desire to maximize return or from a following of organizational fashion to divisionalize, all the firms have been subject to pressure to measure the profitability of individual units. Ackerman notes the implication that the natural corollary of this trend is to limit investment definition to the impact on the defining unit. 13

Justification for a new mill is provided "solely in terms of the impact on the unit to receive the funds." 14 Imperial's kraft group controller discussed new mill plans with Ackerman: 15

Two critical questions were asked during this phase of the analysis: was the wood supply available? And, were the markets there? The Woodlands Division made extensive studies to determine if sufficient timber was available in the locations being considered to support a large mill. Eventually this led to the purchase of a timber company. Meanwhile the corporate market research group was analyzing the market outlook for the kinds of paper and board the mill would produce. We arrived at what we considered to be the average prices the Kraft Group would have to pay for timber in that area and the market prices for kraft paper products now and in the future. From this we were able to put together a financial forecast for the mill and calculate a return on investment.

He went on to explain, however, that:

The investments made in timberland and the later container plants that were built were not included in the analysis. In other words, the mill had to stand on its own.

Some generalizations may be made about the capacity discrepancy which leads to an investment definition, based on data in Chapter IV and on the research finding that the larger are external markets, the less likely is any consideration of investment impact on other divisions.¹⁶ Table VI-2 illustrates changes in recognition of capacity discrepancy with relative size of the external market. Pulpwood production is considered below capacity only in relation to internal needs of the vertical chain because outside sales are difficult in a small and narrow market. The relevant definition of internal discrepancy occurs over varying time horizons with the typical integrated firm producing more pulp than currently required internally in order to assure supply for future internal demand. Broad, large markets for primary and converted products allow recognition of a capacity discrepancy from internal or external demand. We note, however, that there is internal demand for converting capacity in weak markets in order to fully utilize primary capacity. But there is no equivalent demand for primary capacity in weak markets since converting facilities may be operated below capacity with a small loss relative to primary processing, or paper or board

Table VI- 2. CAPACITY DISCREPANCY VERSUS SIZE OF EXTERNAL MARKET ^a

Relative Size of External Market	Stage	Capacity Discrepancy
Small	Woodlands - Pulp	Internal (varying time horizons)
Large	Paper or Board	Strong Market: internal & external Weak Market: no demand
Large	Converting	Strong Market: external Weak Market: internal

^a Source: Resource Planning Institute.

may be purchased on the open market to sustain converting operations. This difference in discrepancy recognition helps explain converting facility investment at low expected returns and the proliferation of converting facilities. In strong markets, primary capacity may be expanded to meet external or internal demand. A primary capacity expansion in a strong market to meet external demand may generate internal demand for converting capacity in a subsequent weak market. Clearly, allowing vertical chain elements to respond as product divisions to external demand without specifically accounting for later impact on other chain elements implies a negative effect on profitability.

Of course, the above are generalizations. Midwest Box has a division philosophy that balanced operations are desirable. Thus, paper or board would never build just to meet external demand, but given the quantum and capital intensive nature of primary processing (one 300 tpd plant serves several 50 tpd converting plants), converting would build to meet board's sales problems.

When the corporate policy is implicit, rather than explicit, the problems with failure to analyze second order investment impacts are magnified. The situation at Universal Paper, a giant integrated firm, is typical. There the board division projects board demand 10 years out for the entire market. This projection includes the converting division's needs only as part of the entire market. Under Phase III and strong world market conditions, board capacity might be expanded for export where price controls do not apply. The expansion decision is made without any consideration of future impact on converting. Similarly, impact on the woodlands division, which supplies all virgin fiber input, is not analyzed since woodlands controls more fiber than current internal needs. In fact, they are permitting their own trees to grow while buying from independent farmers for whom Universal provides seedlings, in order that very long term supply be assured. But there is implicit interdependence. As a Universal corporate officer indicates:

Once you have made the board capacity decision then you go after converting plants: "Come on, fellas, help us get rid of the new tonnage that will be here in 1976."

That statement was made by the same officer who offered the two following comments:

The decision to expand board capacity is independent of converting.

It is a top level decision as to what percentage will be internally converted.

The apparently obvious inconsistencies in the above remarks reflect divisionalization within an integrated chain.

3. Ackerman's research supported his revised hypothesis:

Impact of the division manager in approving investments as business propositions is most strongly influenced by the strategic (product-market) importance of the investment to the corporation.

The strategic importance to the corporation of an investment in a unit varies inversely with the diversity of product-market interests in the firm.

Therefore, as the diversity of product-market interests increases, the influence of the division manager in approving investments as business propositions also increases and, conversely, as the diversity of product-market interests decreases, the influence of the division manager in approving investments as business propositions decreases.¹⁷

This is consistent with Ackerman's observation that effective commitment to projects as business propositions tends to take place at the division and corporate level in non-diversified firms and at the division level in diversified companies, with commitment to the project as a financial proposition occurring at corporate level in both cases.¹⁸

The social and structural context in all our sample firms was such that the corporate level was involved in the business proposition aspect of a decision as strategically important as a new paper or board mill. At Big Box several members of the holding company board had spent their lives in the paper business and brought a paper industry operating philosophy to their decisions. The Chairman of Midwest Box, although a "finance man," had spent his life in the paper business and maintains some detailed control over bleached pulp. In addition, his brother directs kraft mill operations. The kraft group vice president at Imperial indicated:

The President and Chairman may be inclined to "go it alone" in defining the needs for a new mill and in fact may start to think about it a number of years before we become aware of it. Rather than get us all stirred up about a new mill, they may not involve us or the corporate staff at all until the time comes when it should be actively considered.¹⁹

For this new mill, Ackerman reports:

Both the project definition and feasibility analyses were directed from the corporate level; a multi-functional, multi-divisional committee was formed to bring current cost and marketing experience of operating management to bear on developing and analyzing alternative locations for the mill. Central Engineering reported directly to the President as did the committee and those assigned the tasks of compiling and reporting on market forecasts and plans.²⁰

At Interior Paper Company, a large integrated producer examined by Ackerman, the company president described the build-up to a new mill:

The corporation actually purchased the land over a decade ago with the idea that some day a mill would be placed there. However, we made no commitment as to how specifically it was to be used. The Bleached Board Division which at the time had the oldest facilities in the company took advantage of the land and worked up a proposal for a new mill.²¹

These examples illustrate that social context may transcend the more theoretical perspective on corporate involvements in division strategy.

4. Our research is consistent with Ackerman's supported hypothesis that:

As the degree of division interdependence increases, (a) the impact of formal performance measurement systems on investment approval decreases and (b) corporate approval tends to be secured gradually with a supportive attitude toward the investment from other units.²²

In Imperial, effective commitment was received before detailed ROI calculations had been run. The mill commitment developed at length based on comprehensive technical data, but rough return or investment calculations. At Midwest Box, division presidents knew the ROI requirements for corporate approval and this provided an early constraint to commitment.

In cases where the corporation has a viable option to cease investment in the paper industry, financial measures assume greater importance. However, social context in a diversified firm may lessen the viability of the option to leave the paper industry. Only at Midwest Box was a lack of firm commitment to future paper industry investment the acknowledged policy. Big Box has a corporate policy commitment to the industry. The situation is similar for Midwest Packaging, a diversified container firm whose corporate policy is phrased as follows by a division planning manager:

We are in the paper business. We plan to stay in the paper business since over the long pull paper products will always be required.

Thus, despite a corporate "requirement" for a 10 percent after tax return on new assets, Midwest Packaging board division policy is to grow "slightly faster" than the paper industry and have an ROI at least 1 percent greater than the industry. This industry commitment allows the division to justify investments at less than 10 percent, although the latter division goal has not been met in recent years. Such a corporate market share philosophy is common in the industry. Major firms' market shares remain quite constant; all firms in our

sample except Midwest Box considered market share an important performance measure. Similarly, another large diversified packaging firm, Eastern Packaging, belies its "required" rate of return by employing a corporate market-share concept in its tissue division.

The implications are that required pro forma returns are least flexible in Midwest Box and most flexible in Imperial and Consumer Products Company. This generalization applies only to investments at the same point in the vertical chain. That is, Imperial may be less flexible concerning expansion of primary capacity than Big Box concerning expansion of converting in a weak board market.

5. Firms are loathe to depart from industry norms in proposing major capital expenditures. This is reflected in the generally known "efficient" size for different types of plant. No firm in the sample, at least to our knowledge, had analyzed in detail relevant economies of scale; managers worked from rules of thumb and industry norms. Discussions concerning determination of efficient mill size and reasons for its perceived increase proved frustrating. Reasons given by Eastern Packaging managers (who disagreed among themselves) for steadily increasing mill sizes included wood supply and availability of capital, in addition to technology. The two former seem inconsistent with increasing mill size: 1) it is more costly to harvest from greater distances; 2) large forest tracts are becoming more scarce; and 3) industry performance in 1970-72 decreased capital availability.

When Midwest Box paperboard division drew up a new mill proposal, an important consideration in receiving corporate approval was that mill size and machine speed were not at the industry's fringe, but were within successful experience of other firms. Industry cooperation allowed the division controller to get detailed operating cost and technical data from all major competitors. This data was presented in the project proposal to illustrate that the mill characteristics were within others' experience. Similarly, the size of Imperial's proposed mill rested on "informed judgment based on comparison with other firms -- but we try to do a little better," according to Imperial's kraft division planning manager.

When Imperial's kraft division developed a new mill proposal, the production mix included different grades of natural liner, white liner and corrugating medium. Such production flexibility reduces the perceived risk of the new mill. Although some grades are much more profitable to run, the division projected the production mix in the same relative proportions as the current market mix. This results both from their experience of the ability to sell in that mix and from a market share maintenance philosophy not involving aggressive selling. Had the mill been projected to run only the more profitable grades, its pro forma ROI would have been much higher. Since its capacity was only 450 tpd, production of a limited number of grades would not constitute a sizable fraction of the existing markets.

"Required" Return

This subsection briefly outlines the return "required", and its method of calculation, for new primary mills in the firms studied.

Imperial expects a before tax return on net assets of 25-30 percent, excluding allocated overhead, but this return requirement is flexible. Before the investment is finally approved as a financial proposition, three measures are examined: payback, IRR (termed a "profitability index"), and 5 year return on net assets. But during the time effective commitment is developed for the mill as a business proposition, when major engineering studies are completed, the only return figure is the 5 year projected RONA. The figures do not consider investment timing before operation or time weighting of cash flows. The RONA calculation assumes cost increases for various inputs and sales price increases. Typically, pro formas would be run assuming \$2.50/ton and \$5/ton annual sales price increases. These figures are very similar to those of Midwest Box.

At Midwest Box, the paperboard division is required to project a 10 percent after tax 10-year RONA, excluding allocated overhead, to obtain the go-ahead for a new mill. In a tight market, however, 8 percent would justify investment required to keep converting plants supplied. Although Midwest Box performs sensitivity analyses on fiber cost and sales price, risk is not formally considered in its mill proposals.

Big Box aims for a 3 to 4 year after tax payback, but these rates are very flexible. Pro formas include allocated overhead, but initially only one normal operating year and no sensitivity analysis.

Consumer Products Co. has defined its primary corporate goal in financial terms: a minimum earnings per share growth of 10 percent annually. This has resulted in a hurdle rate of 15 percent for profit adding investments, with defensive investments or maintenance of market share considered separately. Their return measure, Venture Rate of Return, is unique to Consumer Co., involving characteristics of lifetime RONA and IRR. Its derivation is much too complex to warrant expansion here. In addition to VRR, Consumer Products Co. examines cash flow, the desired earnings pattern, and is experimenting with a portfolio theory approach.

Pertinent Differences in Investment Process or Perception When Considering a Recycle Mill

Imperial requires a lower RONA for investment in recycling facilities than normally demanded: 18-19 percent before tax compared with 25-30 percent. This is partly the result of a corporate level commitment to consider PCW for capacity increases in order to help raise the national recycling percentage to the National Academy of Science's goal of 35%²³. Part of this commitment stems from a belief that PCW should not be recycled in those grades where it affects quality and price. Also underlying this policy is the desire to give converting divisions the flexibility of government sales by enabling them to meet GSA recycle requirements. For instance, the kraft division's recycle mill proposal planned to run a less profitable board grade which Imperial's converting division could use for government sales. The stress on flexibility to meet overcapacity industry conditions and maintain market share is apparent.

It should be noted that no measure of risk is incorporated explicitly in the pro formas. Implicit risk sensitivity is evident in the statement of shock: "Old corrugated went up from \$22 to \$33 in three weeks because Mead converted a plant to secondary fiber." However, there is no formal risk analysis or consideration of the fact that organizationally a recycle mill would not be on the kraft division's input allocation program, but would have to locate its own fiber supply.

Imperial would not consider backward integration into the paperstock business because a corporate director (an ex-paper industry executive) is personally opposed to it based on the perceived character of the paperstock industry.

Midwest Box makes no differentiation between required returns for recycling or virgin operations. Despite the smaller size of recycle mills, a division V.P. noted to this author that "It's a hell of a lot simpler to build a kraft mill," presumably because the latest technology is standardized and readily available. As to backward integration, the division president said:

Midwest would not integrate backward because everybody knows what that business is like. We would not touch it with a 10 foot pole.

The division controller, describing a major Eastern paperstock dealer and recycler, cautioned this author, "Count your fingers after you shake hands with him."

Midwest also emphasized the price risk with paperstock input, noting that at some mills paperstock is now more expensive per ton than virgin pulp, greatly altering expected return. Of course, virgin fiber is charged at cost in pro formas.

Big Box makes no distinction between recycling and virgin investments. The firm is already a significant factor in the paperstock industry, with its paperstock division the equivalent of most firms' woodlands division. Risk is accounted for only subjectively, but Big Box's knowledge of paperstock allows the division V.P. to believe that he can predict future prices accurately. Big Box's president indicates the industry commitment to recycling:

The extent and rapidity of the recycling rate increase will depend on how quickly the economics turn in recycling's favor, how heavily the industry invests, how extensively environmental concern encourages the acceptance of new recycled products, and how substantially new products and new markets can be developed. I believe the 26 percent rate goal (suggested by Midwest Research Institute and the API) can be achieved.²⁴

Consumer Products Co. has a corporate and package products division commitment to "look into" PCW recycling; they now primarily recycle prompt. They would consider one recycle mill at 12 percent VRR instead of the normally required 15 percent. Three reasons appear behind the desire to have a PCW recycling operation:

- . To improve public relations
- . To open new markets with GSA specifications
- . To learn about PCW recycling.

While it is difficult to weigh these reasons, new markets provide the only quantifiable impetus.

Consumer Products Co. is concerned with quality and price fluctuations of PCW. Any product which could jeopardize Consumer Products Co.'s competitive position would have to be marketed under an off-brand or private label name. However, no sensitivity analysis to explicitly account for risk is performed.

Consumer Products Co. has the typical industry view of the paperstock business. The packaged products division planning manager commented: "Most people in the tissue industry who use PCW are shysters with no reputation or quality product." A fiber division officer expressed grave concern that if a subsidy were to go to processors of secondary fiber, "Mafia" related city control would result in "municipal gangsterism."

CHAPTER VII: SUBSIDY IMPACT ANALYSIS

This chapter presents the results implied by our research findings in terms of our initial hypothesis that selected incentives will significantly affect the recycle mill investment decision. The major implication of our work is that while comparative rates of return are related to sub-industry recycling levels; strategic, structural and social contexts make a comparison of pro forma IRR's a poor predictor of investment decision making when considered alone. While this chapter does present data on subsidy financial impact and on the paperstock industry, that implication should be evident at this point.

First, the chapter will present the results of applying selected subsidies to the sub-industry models developed in Chapter V. Then it will summarize the importance of contextual factors developed in Chapter IV and Chapter VI to the recycling decision.

Financial Impact

Six subsidies were selected to represent a range of possibilities. The six are:

1. Five year depreciable lives for plant and equipment. We still allow accelerated depreciation and the 7 percent ITC.
2. \$10/ton subsidy to secondary input.
3. \$20/ton subsidy to secondary input.
4. 18% of secondary input purchase cost, including freight.
5. 50% of secondary input purchase cost, including freight.
6. 20% ITC for the recycle plant and equipment (here assumed to be the entire mill).

The above subsidies were applied to our mill model framework to generate pro forma financial impact.

Table VII-1 shows the impact on linerboard. None of the subsidies make recycle linerboard financially competitive with virgin on a payback or IRR measure. The only one that comes close is the 50% of input cost subsidy, which amounts to \$22 per output ton.

Table VII-2 illustrates subsidy financial impacts on corrugating medium. The \$20/ton and 50 percent of input price subsidies make recycle medium competitive or superior to virgin in financial terms and acceptable to Imperial and Midwest Box on return terms.

Table VII-3 illustrates subsidy financial impacts on .016-.018 caliper folding boxboard. All returns in this table, including virgin, are high by industry standards and meet new investment return criteria of all sample firms except Big Box. Even for Big Box, 5 year depreciable lives, \$20/ton, and 50 percent of input cost subsidies yield acceptable returns. Recycle boxboard is at all times a significantly superior pro forma financial proposition, as compared with virgin boxboard.

Table VII-4 shows subsidy financial impact on .022 caliper folding boxboard. Without a subsidy the financial decision is close, with recycle marginally better financially. Subsidies do not push it to the point at which Big Box would invest, but several do go over the hurdle rate for the remaining firms.

In summarizing the financial data, it may be noted that the larger incentives have a potentially meaningful, though not overwhelming, financial impact only for corrugating and higher caliper folding boxboard.

Social, Strategic, and Structural Contexts and the Recycling Decision

Social context is an important element intertwined with strategy and structure and will be briefly discussed before analyzing strategic and structural context. The important aspects of social context as they affect the investment decision in most firms may be summarized as follows:

- . A commitment to the paper industry normally thought of in virgin "forest product" terms.
- . Corporate management familiarity and identification with virgin operations.

Table VII-1. SUBSIDY FINANCIAL IMPACT: LINERBOARD^{a,b}

	IRR	Payback	5 Year Return on Net Assets
Virgin Linerboard	9.1	10	13.4
Recycle without subsidy	4.3	18	9.3
Recycle with subsidy			
1. 5 yr. depreciable lives for P & E	6.1	14	NA
2. \$10/ton input	7.8	11	12.2
3. \$20/ton input	10	9	14.6
4. 18% input	7.4	12	11.9
5. 50% input	10.9	9	15.5
6. 20% ITC	6.6	16	13.31

^aSource: Resource Planning Institute.

^bReturns are after tax, accelerated depreciation with 7% ITC for all but #6.

Table VII-2. SUBSIDY FINANCIAL IMPACT: CORRUGATING MEDIUM ^{a,b}

	IRR	Payback	5 Year Return on Net Assets
Virgin Medium	11.3	8	15.9
Recycle without Subsidy	7.5	12	10.4
Recycle with Subsidy			
1. 5 year depreciable lives	9.1	9	NA
2. \$10/ton input	10	9	13.9
3. \$20/ton input	13.5	7	17.5
4. 18% input	9.9	9	13.1
5. 50% input	13.8	7	17.8
6. 20% ITC	9.4	12	14.4

^aSource: Resource Planning Institute.

^bReturns are after tax, accelerated depreciation, and include the 7% ITC for all but #6.

Table VII-3. SUBSIDY FINANCIAL IMPACT:
.016-.018 CALIPER BOXBOARD ^{a, b}

	IRR	Payback	5 Year Return on Net Assets
Virgin .017 Caliper	12.5	7	17.4
Recycle .018 Ultraformer without subsidy	16.6	6	22.7
Recycle .018 Ultraformer with subsidy			
5 yr. depr. lives	19	4	NA
\$10/ton input	18.8	5	25.8
\$20/ton input	20.9	5	28.8
18% input	18.2	5	25
50% input	21	5	28.9
20% ITC	19.5	6	26.3
Recycle .018 Dry-Formed without Subsidy	31.3	4	38.6
Recycle .018 Dry-Formed with Subsidy			
5 yr. deprec. lives	35.6	3	NA
\$10/ton input	33.9	3	42
\$20/ton input	34.8	3	42.8
18% input	33.2	3	41
50% input	36.5	3	45.3
20% ITC	36.7	4	42

^aSource: Resource Planning Institute.

^bReturns are after tax, accelerated depreciation, and include the 7% ITC except for #6.

Table VII-4. SUBSIDY FINANCIAL IMPACT: .022 CALIPER
FOLDING BOXBOARD ^{a, b}

	IRR	Payback	5 Year Return on Net Assets
Virgin	9.1	10	13.6
Recycle without Subsidy	9.4	10	13.8
Recycle with Subsidy			
5 yr. depr. lives	10.9	8	NA
\$10/ton input	12.1	8	16.9
\$20/ton input	14.5	7	19.9
18% input	12.3	8	17.1
50% input	16.1	6	22.2
20% ITC	11.3	10	17.4

^aSource: Resource Planning Institute.

^bReturns are after tax, accelerated depreciation, with 7% ITC in all but #6.

- . The high level of involvement of top management in a new mill decision.
- . Top management's concern with the recycling issue and general willingness to look favorably (perhaps only because of perceived future pressure) on an exceptional, or unusual, venture into PCW recycling outside the corporation's normal strategy.
- . Perception that the waste paper business and its operators are undesirable, of different ethnic background, and not suitable for backward integration.

With social context as a concomitant we may proceed to Table VII-5 which summarizes the comparative interaction of strategic and structural decision contexts with characteristics of virgin and secondary systems. It divides the industry characteristics into five segments based on position in the vertical chain: fiber stock; fiber gathering and transport; pulping; paper and board manufacture; and converting.

Fiber Stock and Fiber Gathering

The characteristics of a capital intensive vertical chain enumerated in Chapter IV imply the importance of guaranteed supply quantity and quality. Integration pressure has resulted in "ownership or control" of pulpwood by most major paper manufacturers. This compares to the 27 percent control of paperstock sources shown in Table VII-6. Where that paperstock control represents captive prompt the problems of supply quantity and quality do not exist; such waste is easily used as a pulp supplement. However, a portion of the 27 percent represents captive dealers whose quality and quantity may or may not be wholly dependable. Much of the "other" category represents non-captive mills, converters, or consumers, as in the case of Consumer Products Company's recycling of vinyl top paper. Such sources are rarely under long term contract and present considerably more supply risk than virgin channels.

Figures VII-1 and VII-2 reflect comparative price changes among industry segments and between virgin pulp and waste paper. Secondary fiber is by far the most highly fluctuating of all chain elements. It should be noted that non-waste prices reflect list, and not actual. While there is little

Table VII-5. INTERACTION OF STRATEGIC AND STRUCTURAL DECISION
CONTEXT WITH CHARACTERISTICS OF VIRGIN AND SECONDARY BASED SYSTEMS^a

	VIRGIN		SECONDARY	
	Strategy	Structure	Strategy	Structure
FIBER STOCK	- Major portion owned or controlled - Supply very certain in amount and quality---"own or control" - Many long term contracts - Vertical integration fosters a social context which reverses the <u>forest</u> product image	- Cost center since small market - Transfer price (TP) is cost based - TP is certain - Woodlands division supplies all needs of other divisions - Planning dependent on other divisions - Performance measured against budget, very predictable costs	- Do not control, except captive prompt - Dependent on uncertain supply, except captive prompt - Availability & quality vary greatly, except captive prompt - Few long term contracts - Supply sources perceived as undependable	- Comes in at market price (even captive prompt) - Highly fluctuating costs - TP is market - Responsibility for fiber source location often rests with mill manager, not a corporate division - Initial planning of mill often done by virgin based personnel with little past interaction with waste markets except for small fiber supplements - Social context Perception at all mgmt. levels that PCW processors and brokers are not acceptable people to deal with, let alone trust - Quality problems make trust a requirement
GATHERING AND TRANSPORT	- Contracted outside but under long term arrangements often involving loans of equipment or funds. - Increasing pressure for corporate ownership from labor supply problems (welfare related)	- Controlled by Woodlands Division - Contracted out because of unpleasant nature of work and labor practices	- No control by paper firm except for captive prompt & those rare owned dealers - Supply risks providing increased pressure to integrate into waste paper business	- Responsibility and risks rest with mill manager - Social context perception that the business & those involved are undesirable

Table VII-5 (CONTINUED)

	VIRGIN		SECONDARY	
	Strategy	Structure	Strategy	Structure
PRIMARY PHASE I: PULP	. Pulpwood sources almost always captive . Certainty of supply high but decreasing . Only the smallest mills not integrated through paper or board . Economies of scale significant . Capital Intensive . Large Investment . Operations orientation . Much industry-standardized technology . Above three points, combined with location of booked profit have resulted in steady process improvement and a learning curve effect	. Cost based TP generate large book profit here . Balance with other units critical because of high cost of dry pulp . Woodlands controls allocation of pulpwood to all mills and pulp to non-integrated mill . Comparative cost performance appraisal at mill level	. Non captive paperstock sources . Always integrated through paper or board . Economies of scale not so significant . Less capital intensive, smaller investment . Not much industry standardized technology relative to virgin	. Each mill responsible for its own fiber supply . Input at market prices . Supply risks in price, quality, and quantity are mill manager's responsibility . Performance appraisal at mill level difficult because of uncertainties of secondary market
PRIMARY PHASE II: PAPER OR BOARD	. Pulp almost always captive . Industry-standardized operational improvements . Large investment . Capital intensive . Economies of scale significant	. Input at cost based prices . Place where profit booked (same as pulping for integrated mill) . Output transferred at market . Division is responsible for all converting needs . Comparative cost performance appraisal	. Always integrated with pulping . Not industry standardized . Fewer standardized technological improvements . Smaller investment . Not so capital intensive . Economies of scale not significant	. Input at market . Output at market . Thus appears less profitable than virgin counter part

Table VII-5. (CONTINUED)

	VIRGIN		SECONDARY	
	Strategy	Structure	Strategy	Structure
CONVERTING	Least integrated		• Except for supply, least integrated segment • Concern about anything which would open or limit markets: a. recycled products "disadvantages" b. government sales	

^a Source: Resource Planning Institute.

Table VII-6. SOURCES OF PAPER STOCK, 1969^a

	Percent
Independent Dealers	66
Captive Sources (dealers and prompt controlled by users)	27
Other Mills or Converters	7

^aSource: McClenahan. "Consumption of Paper Stock by U.S. Mills in 1969 and 1970."

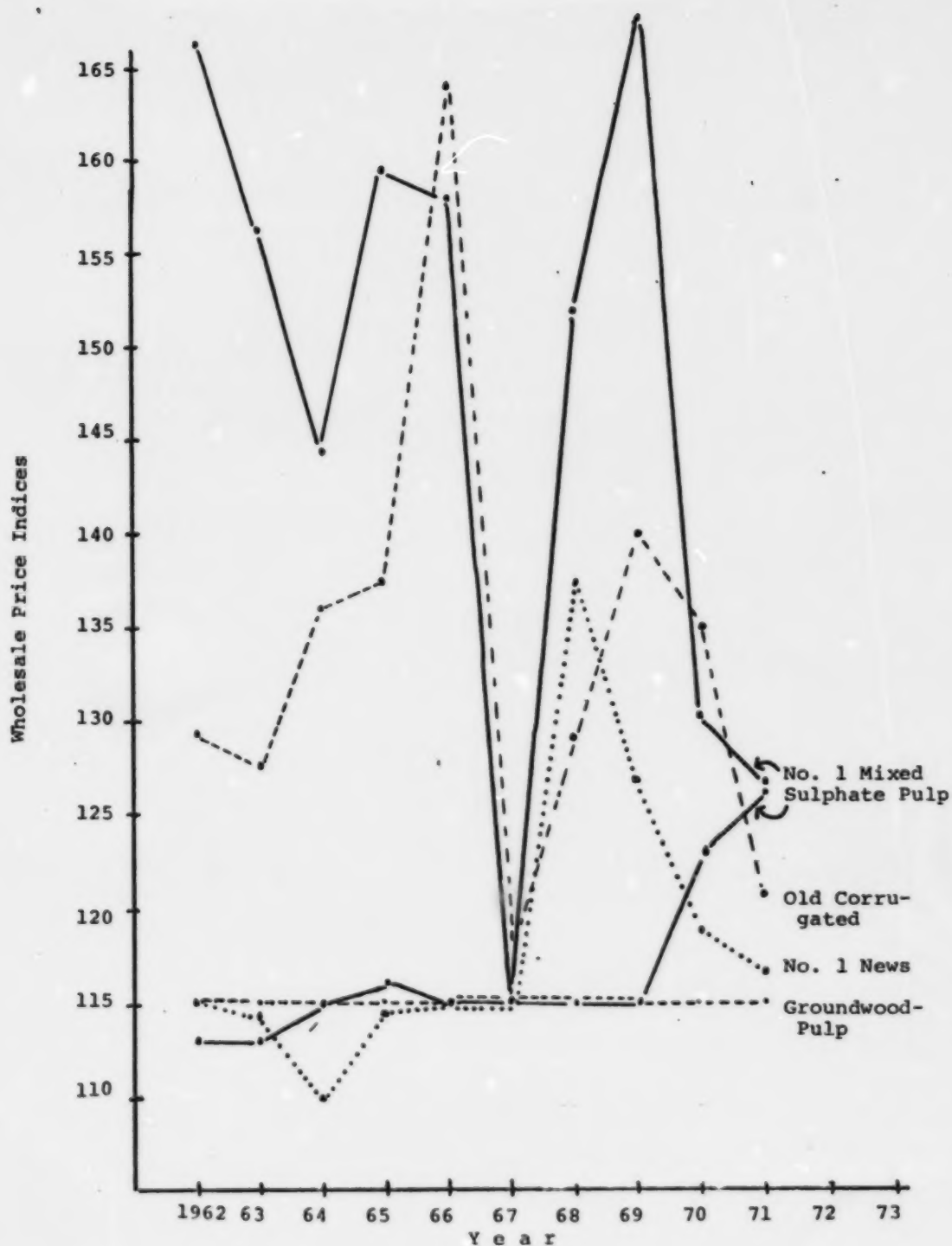


Figure VII-1. Pulp and Waste Price Indices. Source: Bureau of Labor Statistics, Wholesale Prices and Price Indexes. Various issues. U.S. Department of Labor, Washington, D.C. as reproduced by American Paper Institute, Statistics of Paper 1973, p. 40.

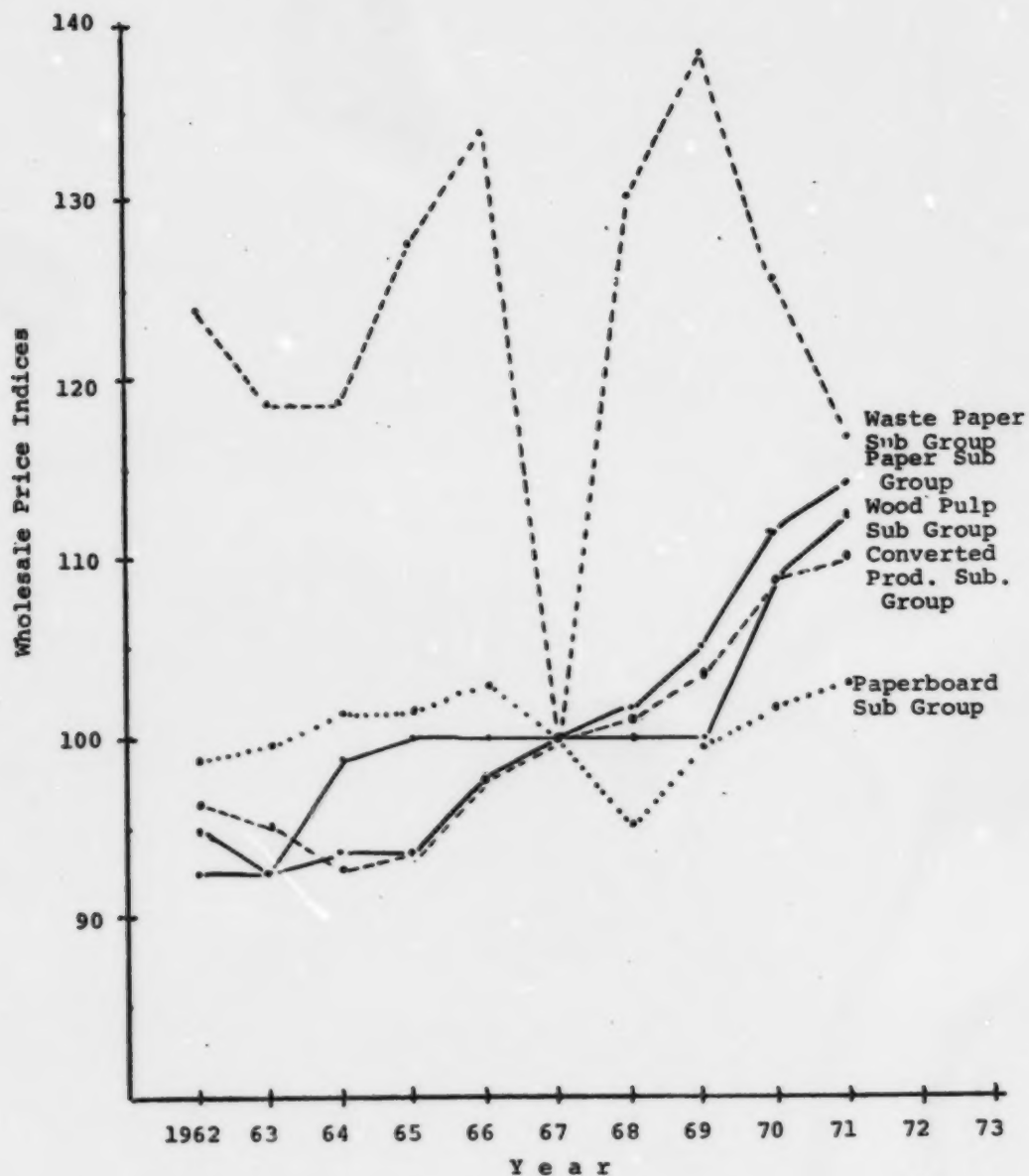


Figure VII-2. Industry Sub-Group Price Indices. Source: Bureau of Labor Statistics, Wholesale Prices and Price Indexes. Various issues. U.S. Department of Labor, Washington, D.C. as reproduced by American Paper Institute, Statistics of Paper 1973, p. 40.

data available concerning the differences between list and actuals, we are safe in assuming that the relative prices are reasonable reflections of comparative risk, if only because so much virgin fiber flows through fully integrated chains.

A factor behind the high price fluctuations in secondary fiber is its use as a pulp supplement in strong markets. While paper and board machines may expand output for brief periods, and often build up capacity in excess of pulping capacity, the addition of modest amounts of virgin pulping capacity is economically prohibitive due to its capital intensive nature. However, for many products 5-10 percent waste may be added to the mix with little expensive pulping investment, often using the in-house prompt pulper. Further, in strong markets, quality of delivered product is more flexible. When this marginal input consideration is combined with the short-run inelasticity of waste paper supply, highly fluctuating prices are to be expected.

Several factors may be noted behind the short term inelasticity of supply. A major one is the nature of waste sources. Since waste is a derived product its total stock is very price inelastic. Secondly, the nature of waste sources remaining to be developed indicates time and effort are required to generate a meaningful supply. Importantly, the failure of most paper firms to integrate backward and thus make a long term commitment to use of waste from a specific source has left the paperstock market generally composed of small dealers and brokers.¹ Given the lack of concentration in the paper industry, this implies low concentration of buyers and sellers in the major waste paper markets,² although some local markets are partially oligopsonistic. In addition, the paperstock business is not capital intensive relative to virgin, and involves little investment. This implies ease of entry and low financial resource requirements. These factors combine to imply an unwillingness or inability of current paperstock dealers to expend resources developing the supply of waste in the face of fluctuating demand.

The disadvantages of secondary fiber price fluctuations are accentuated in times of price control. Most small dealers are exempt from price controls; while as wastepaper prices rise large paper firms may not be able to recoup the cost increases through higher prices.

The above very real problems with secondary fiber as supply source for a capital intensive vertical chain are compounded

by the perception of paperstock dealers and brokers, including some acquired in backward integration, as shysters or "Mafia" types with whom a respectable paper firm should be very reluctant to associate. Several factors may be hypothesized as underlying this perception. The nature of the waste business, its location and employees, are very different in social and organizational context from the middle and upper levels of major paper firms. Many paperstock dealers are one to three establishment firms.³ This author's limited observation indicates that most scrap firms are family businesses. The nature of much of the business, involving the sorting, baling, and storing of dirty, low value products, implies location in run-down, unattractive buildings and areas. The small size of most firms implies that the owner of the firm is usually on these premises and familiar with the details of the operation. While low wages and undesirable working conditions in a paperstock dealer's operation are somewhat similar to virgin raw material gathering, the rural setting makes the latter less visible and more palatable. These conditions alone indicate that a corporate executive would not be expected to relate well to a typical paperstock dealer. Added to this are substantial ethnic differences; it is a reasonable assertion that many paperstock dealers are "ethnics" of Italian or Jewish extraction, while this is not the case with paper firm executives. Both paper firm executives and paperstock dealers enjoy comaraderie within their industries, the latter being viewed askance by the paper firm executives. In an industry where supply quantity is critical and difficult to guarantee efficiently, disparate social contexts result in a lack of trust in waste dealers as a supply source.

In addition to supply source characteristics, virgin and secondary fibers generally differ with respect to organizational handling (except in Big Box). Virgin fiber is allocated by a woodlands division responsible for supplying all other divisions' virgin needs. Cost based transfer prices are low and stable. Secondary fiber must normally be obtained by the mill manager, sometimes with the help of a division waste expert. Both the risks and responsibility are placed much lower in the organization. Only at Big Box was the organizational context the same for virgin and secondary.

Pulping, Papermaking and Converting

Appendix XXVI illustrates the high percentage of captive pulp, 98 percent for unbleached sulphate, introduced into paper

and board manufacture. From the point of view of the paper mill this is to be compared with the 27 percent of Table VII-6 since secondary pulp mills are almost always part of a paper mill. The pressures for integration which have forced such a high captive pulp percentage highlight the disparity between the needs of a vertical chain and the present interface with the secondary materials market. These pressures have resulted in continued operational improvement and a learning curve effect in virgin technology. The virgin learning curve applies on an industry basis as a result of standardized technology and the social context of industry comaraderie which have not largely been shared by the more disparate secondary operations.

Profit is booked at the usually integrated pulpboard mill stage in the virgin chain. Input is transferred at a cost based price and output is transferred at the market based prices even if completely controlled by an in-house allocation system. This is also the most capital intensive stage and the one for which most top management feels most concern and interest. This stage in a secondary based system is less capital intensive and does not record such large profits since both inputs and outputs are transferred at market. Further, those profits fluctuate rapidly with the uncontrollable waste supply.

Concern with keeping the primary, capital intensive stages in operation dominates converting strategy in an integrated company. In the past this may have meant worries over perceived market disadvantages of recycled products. Currently this concern involves a desire for the flexibility of possible government sales in tight markets or the maintenance of market share. The present and potential GSA recycle requirements are a factor in many firms' strategies.

Revised Hypothesis #1

Our original hypothesis that selected incentives will significantly affect the recycle mill decision may now be revised as follows:

1. While recycling rates vary in the expected direction with differential pro forma returns, the impact of selected subsidies does not appear significant in financial terms, except for \$20/ton or 50 percent of input price applied to medium and boxboard. It was observed that:

- a. Prompt waste is recycled fully without a subsidy.
 - b. A dollars per ton subsidy rather than a subsidy based on investment or a percentage of cost directs itself relatively more to the bulk, low quality grades where lack of mobility and contextual interface problems are most severe.
 - c. Capital subsidies are complex in relation to return calculations performed at the time of effective commitment.
 - d. Any subsidy needs to be guaranteed for a period reasonable in light of mill life, which is approximately 40 years.
 - e. Tax subsidies are less desirable from an efficiency point of view (see Appendix II), but are favored by the industry because of their perceived permanence.
2. Structural, organizational, and social contexts are significant factors in the recycling decision.

The implications of 1. and 2. suggest two additional hypotheses:

3. While the willingness to invest of those firms currently considering a one time or special venture into the recycling business may be increased by more than the financial impact a subsidy would imply, over the long run, contextual factors substantially lessen the apparent overall impact of a financial subsidy.
4. Major increases in recycling will only come when secondary fiber sources are made to better interface with the context of the paper industry. Corollary: Subsidies which act within the context of the industry, like GSA purchase subsidies, have a greater impact than their financial statistics imply.

Our second original hypothesis, initially advanced in Chapter I, concerning the justification for federal action, will be addressed in Chapter VIII.

CHAPTER VIII: IMPLICATIONS FOR GOVERNMENT AND BUSINESS POLICY AND FOR FURTHER RESEARCH

Determination of the desirable course for the federal government to pursue is twofold: examination of possible justification for governmental involvement, and, if justified, determination of the action most desirable from a cost/benefit standpoint. The latter includes, but is not limited to, monetary outlays and savings. It includes our concept of "impact" and the costs of a given set of impacts.

The justifications for examining government intervention through subsidies were outlined in Chapter II. The subsequent development of research findings supported such examination.

Even without drawing on this paper's research, it may be concluded that externalities of paper solid waste provide a theoretical justification for analyzing possible government intervention in the "market" economy. Producers and consumers of products whose waste finally enters the solid waste stream do not bear the total social and monetary cost of its collection and disposal. Similarly, those whose total social and monetary costs are reduced by the recycling industry do not have an effective mechanism for payment outside government action.

Lack of factor mobility, both human and capital, resulting from strategic, structural, and social contexts is a serious problem with respect to the decision to build a new secondary based mill. This lack of mobility causes the industry to make investment decisions not optimal from society's viewpoint.¹

Imperfect information is a relative condition difficult to quantify. Certainly information about recycling is less industry standardized and thus in many ways less well-known. But this is a very natural outgrowth of the industry's strategic, structural, and social contexts. As Appendix II notes, advisors must be wary of the "nincompoop thesis" in which they fault others for "incorrectly perceiving trade-offs."² It is clear that the major process learning of the last 100 years has been in virgin based systems. In a production/process based, mature technology industry

reflecting economies of scale, this has meant that current virgin systems are significantly further down their learning, or experience curves, than most secondary systems. (The learning curve expresses mathematically the decreasing relationship between unit costs and cumulative production.) The experience curve phenomenon is partially reflected in the efficiency, large size, and common technology which are characteristic of the more prevalent virgin operations. The cumulative impact of virgin dominance and process learning has been self-reinforcing. It is a reasonable hypothesis that the slope of secondary system learning curves is much greater and that secondary based research would yield a higher return at present. This conclusion is given support by the relatively large number of new processes and techniques generated recently in secondary systems (waste recovery systems, dry-forming, separation of medium and liner, etc.) since attention has been directed to these alternatives.

The decreasing cost industry argument might be used as a justification for examining substantial expansion of the supply of available waste on a permanent basis. This could provide a supply source more strategically matched to the context of the paper industry than the current numerous small paperstock dealers. Municipal separation systems might allow recovery of many secondary materials simultaneously at lower per unit costs.

Implications for Federal Policy

The arguments outlined above support the examination of possible federal intervention into the market mechanism via subsidies. This paper has been one contribution to that analysis. Before actual government intervention could be justified a comprehensive cost/benefit study is required comparing the non-intervention situation with conditions under specific intervention strategies. While the measurement of total social costs and benefits, including income transfers, externalities, dislocations, and intercriteria weightings is far beyond the scope of this paper, we shall attempt to sketch some aspects of costs and benefits and assess government policy implications.

With only current levels of federal intervention in the recycling issue (some demonstration grants, GSA purchasing specifications, funding of research studies such as this, and applicability of municipal industrial revenue bonds in some instances) recycling rates for paper are predicted to

increase during 1972-1975.³ Table VIII-1 reflects the most recent American Paper Institute capacity survey,⁴ indicating an increase of two percent in the recycling rate by 1975. An analysis of the data shows that in the paperboard area most of the projected capacity increase is a result of improvements rather than new mills or board machines.⁵ Only in unbleached kraft linerboard and semi-chemical paperboard do new machines play a significant role, and even in those cases not until 1975. Scheduled new machines in newsprint and printing, writing, and related cause total paper to register a more balanced capacity increase between improvements and new machines as the balance swings strongly to new machines in 1975.⁶

The projected increase in waste paper use is consistent with the expansion of capacity through incremental process improvements. Although most of the firms in industry are operating at capacity, rising capital costs and return criteria, combined with a price control environment, encourage the easily justified marginal investment in process improvements. Addition of new virgin pulping capacity entails major investment, while additions to waste pulping operations or the introduction of some waste to a virgin operation require little investment, making them very profitable at the margin. Thus, waste fiber use may be expected to rise in full capacity situations. This helps explain the projected average annual increase for 1974 and 1975 of 5.7 percent for waste paper pulp.⁷

Assessing the permanence of the recent trend towards slightly increased recycling is a very difficult task. Midwest Research Institute concluded:

The forces that led to the declining rate of waste paper recycling - availability of vast forest resources, unfavorable economics, competitive virgin fiber product specifications and performance, and more efficient pulpwood technology - still generally prevail.⁸

Certainly the average cost of virgin fiber will increase as suitable sites for large new mills become more scarce and as increased forest management expenses are incurred to raise fiber output. Although current levels of forest management and pulpwood technology could result in a future virgin fiber shortage at today's prices, there is no evidence that methods of virgin supply expansion will not be put into practice.⁹ These changes will drive virgin costs up. But recycling costs will increase with recycling levels as a result of the high labor component

Table VIII-1. CAPACITY AND RECYCLING RATES 1971-1975
FROM AMERICAN PAPER INSTITUTE DATA^a

Year	Year end capacity, all grades paper & board (000 tons)	Capacity increase (percent)	Waste paper con- sumption in paper and board manu- facture (000 tons)	Increase in waste paper consumption (percent)	Waste paper as a percent of total fiber consumed
1971	60,702	3.0	12,323	2.5	21.6
1972	63,563	4.7	13,132	6.6	21.4
1973F	65,157	2.5	14,096	7.3	22.1
1974F	66,730	2.4	15,042	6.7	22.9
1975F	69,372	4.0	15,762	4.8	23.4

^aSource: American Paper Institute, "Capacity 1972-1975 Pulp, Paperboard, Woodpulp", American Paper Institute, New York, 1973, pp. 3,5,20,21; except 1971 recycling percentage where total fiber consumed is from the American Paper Institute, Wood Pulp Statistics 36th Edition, 1972, p. 58. It should be noted that American Paper Institute derived recycling percentages are higher than the Bureau of Census based data.

and the difficulty of locating and utilizing presently untapped sources of waste.

Although the strategic, structural, and social contexts of the industry weigh heavily against a major move toward recycling, several additional factors clearly favor recycled processes. Energy use is smaller to repulp than to initially pulp, and the dry forming process could save more than 66 percent of energy normally required.¹¹ If pollution control costs rise as a result of stricter standards and enforcement and/or the public becomes more sensitive to recycling and reduces the required whiteness level of paper products (less bleaching), some recycled products will be more competitive from an appearance standpoint. Recycling is now less polluting for board products which do not require de-inking. Stricter air and water pollution laws will have a significant effect on some chemical pulping processes, particularly enhancing recycle medium over semi-chemical. Consciousness concerning recycling, government purchase specifications, and the steeper slope of recycling's learning curve, combined with some commitment to that learning, argue for increased recycling.

The projection of anticipated or possible recycling levels is a complex task beyond the scope of this study. We shall, however, outline a range and attempt a rough benefit/cost discussion. As an upper limit, Dr. Benjamin Slatin, American Paper Institute economist, has indicated a maximum recycling level of 40 percent based on a 50 percent waste stream recovery rate and assumptions concerning fiber degradation with successive repulpings (20 percent lost in the first recycle, 25 percent lost in the second, 33 percent in the third, 50 percent in the fourth, and 100 percent in the fifth).¹² Figure VIII-1 illustrates recycling levels in other countries. Presumably, higher recycling rates result from a smaller relative supply of virgin fiber, different labor/capital relative costs, and a different contextual environment. Even within the U.S., waste paper constituted 36.6 percent of total fiber input in 1944.¹³ However, it should be remembered that this occurred during a wartime environment and before wide use of the kraft process on southern hardwoods and wood residues.

Major additions to recycling, as compared with marginal increases, will require changes in supply source and collection mechanisms. Arthur D. Little, Inc. provides Figure VIII-2, illustrating metropolitan area size versus ability to supply a 100 percent recycle linerboard mill. They identify 14 multiples of 5 million population within a 50 mile radius

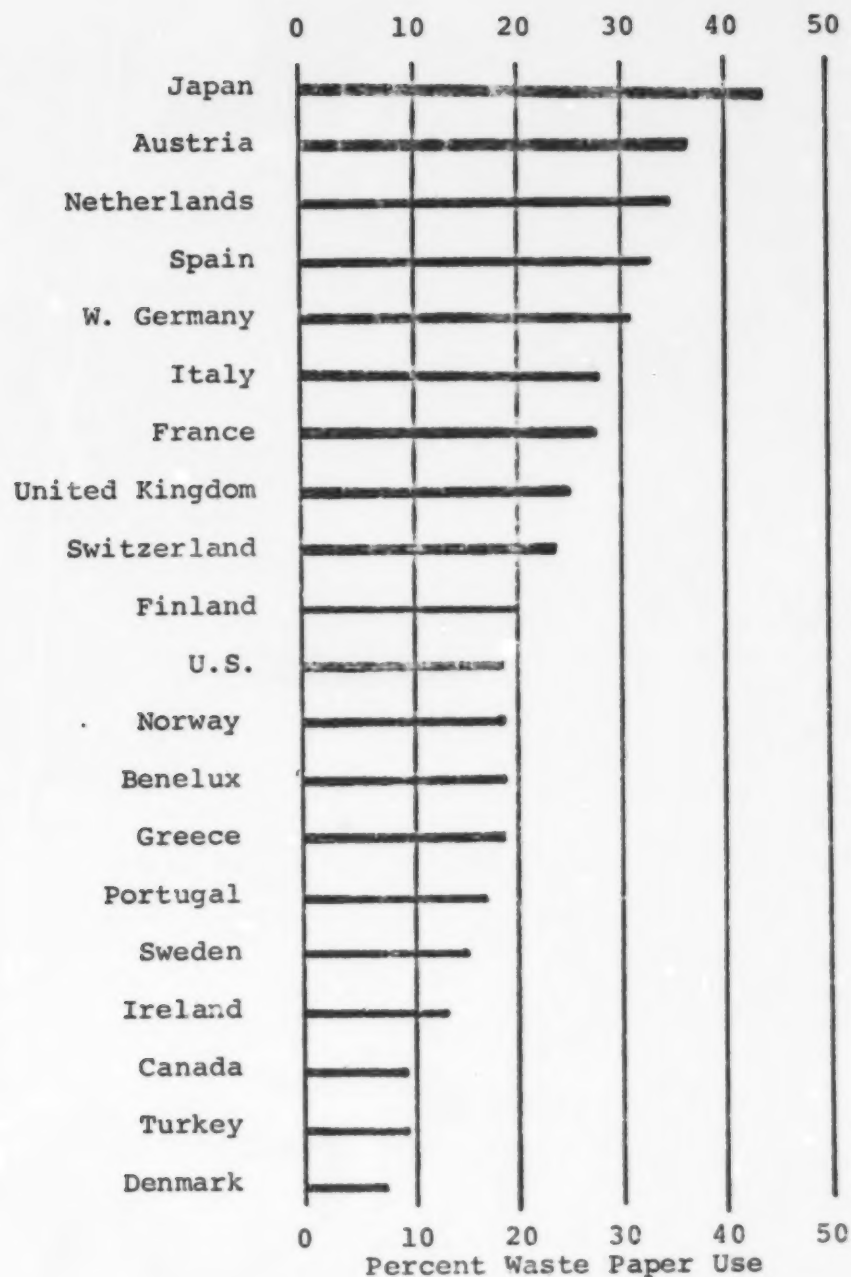


Figure VIII-1. Waste Paper Usage in Various Countries. Source: Wayne Carr. "Many Problems Involved in Increasing Utilization of Waste Paper" Paper Trade Journal, May 17, 1971, p. 50.

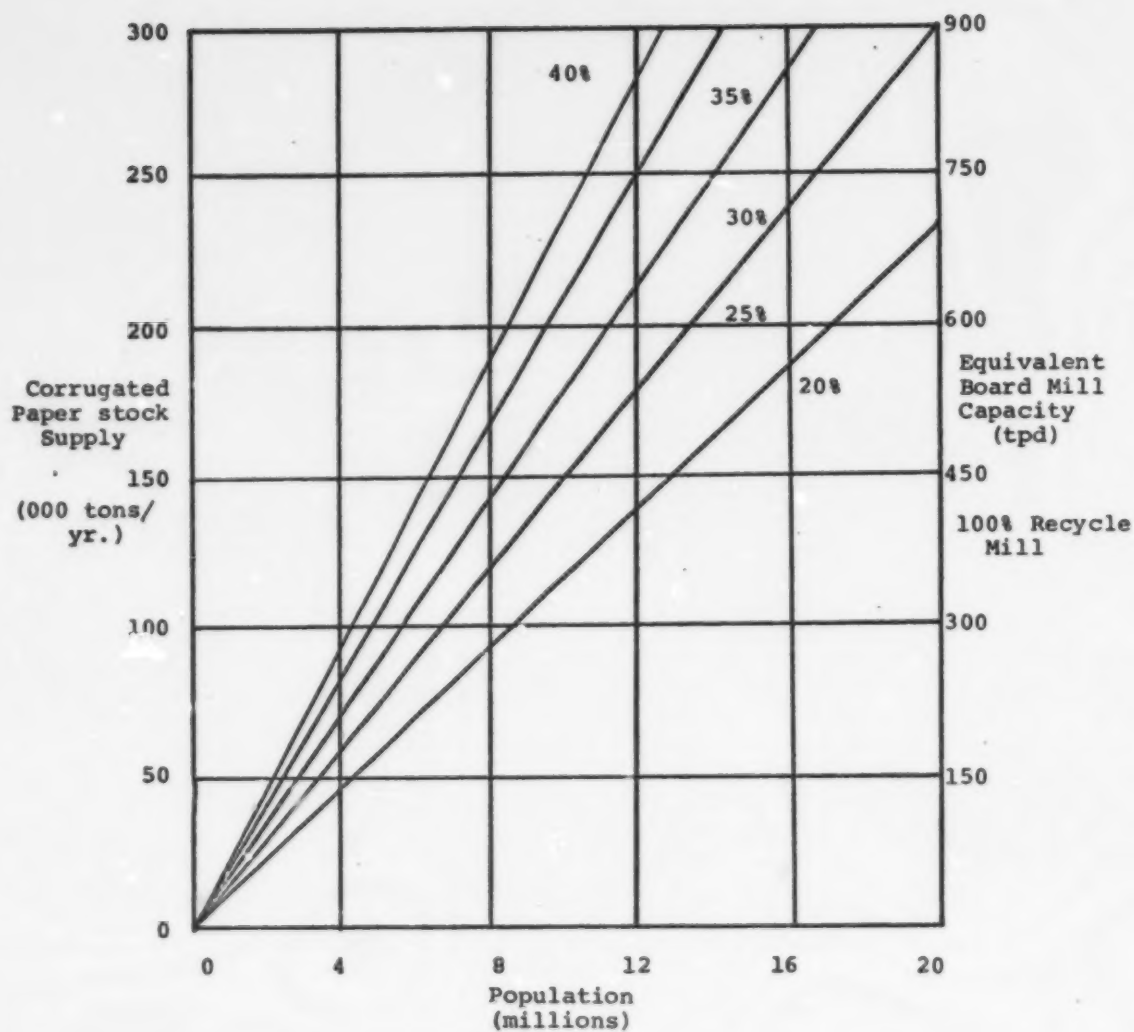


Figure VIII-2. Potential Supply of Used Corrugated Containers at Different Recovery Rates. Source: Arthur D. Little, Inc., Can Federal Procurement Practices Be Used to Reduce Solid Wastes, op. cit., p. 91. Containerboard Consumption, 120 lb/person/yr.

of possible plant locations in the U.S.¹⁴ Clearly, this limits the potential increased recycling from large 100 percent recycle mills like the 300 tpd medium mill in our Chapter V model. It should be noted, however, that some grades, including corrugated, may be recoverable at substantially higher rates than the average.

Midwest Research Institute, in a well-regarded study of waste paper availability, which involved analysis of geographical imbalances and the interaction effects of specific waste paper grades as potential inputs to different end products, concluded that the most plausible recycling rate, given changes in public policy (like subsidies) and increased demand, was 26 percent in 1985.¹⁵ Midwest Research Institute predicted that recycling would decline to 17 percent without these changes.

This author concludes that current factors and the level of government involvement already identified which favorably effect recycling relative to virgin are likely to prevent the recycling rate from declining below the 1971 level of 19.8 percent noted in Table III-2. But, given contextual factors and current economics, we do not see the short-term projected increase as a permanent turnaround without greater government intervention.

The model analysis indicates that a subsidy at least on the order of \$20/ton would be necessary to meaningfully change the economics of recycling. For linerboard (Table VII-1) and corrugating medium (Table VII-2) the \$20/ton input subsidy is the smallest incentive which causes recycling to yield a higher IRR than virgin production. Folding boxboard (Tables VII-3 and VII-4) shows higher IRR's for recycled board even without a subsidy. Assuming the subsidy applies only to post consumer waste (reasonable since almost all prompt is now recycled), we can generate anticipated direct costs to the federal government at different recycling levels. Using 1970 as the comparison year, and assuming any increase in recycling is all PCW, we arrive at Table VIII-2. This table highlights the significant impact of windfalls in the subsidy issue. Here a windfall refers to the subsidy paid for PCW recycling which would have occurred without a subsidy. If the increase in recycling with a subsidy is only modest, windfalls generate a high budgetary cost per incremental ton recycled.

Even these numbers substantially understate actual costs in the period under 15 years. Substantial enforcement difficulty would exist in limiting the subsidy to PCW.

Table VIII-2. \$20/TON DIRECT SUBSIDY, HYPOTHETICAL COSTS
AT VARIOUS RECYCLING LEVELS, 1970
PRODUCTION LEVEL

Recycling Rate (percent)	Direct Expenditure (\$ millions)	Cost per incremental ton recycled (\$)
20	143	-
25	198	72
26	209	63
30	252	46
35	307	37

Source: Recycling rate is for prompt and post consumer waste. Post consumer waste is assumed to represent 65 percent of the actual 1970 recycling rate (based on author's analysis of data in McClenahan, "Consumption of Paperstock in U.S. Mills in 1969 and 1970") and all of any increase over the 20% recycling rate. Direct expenditures are \$20/ton of PCW based on a 1970 total fiber consumption of 54,809,648 tons from U.S. Bureau of the Census, "Current Industrial Reports Series M 26 A (13)." Cost per incremental ton recycled reflects the total subsidy cost (payment for the 7.14 million tons of PCW recycling which occurred without the subsidy and the payment for incremental recycling) divided by the incremental tons recycled.

Subsidies would not be expected to achieve a 30 percent recycle rate until the next cycle of mills replaced those currently in operation, since abandonment of usable virgin capacity or shipment of waste long distances would be uneconomical, unless the subsidy were extremely high. This implies a higher incremental cost than shown for at least the first 15 years. Further, if production follows Midwest Research Institute forecasts, total direct expenditure in 1970 dollars would rise to 1.76 times the 1970 level in 1985.¹⁷

The total amount of direct expenditures and of windfalls could be reduced over the medium term (the period before all extant capacity is replaced) by limiting the use of an investment subsidy to new recycling plant and equipment. Such a subsidy would have to be much larger than a 20 percent investment tax credit (ITC) or 5-year depreciable lives in order to have a meaningful impact similar to a \$20/ton or 50 percent input cost subsidy. Equitability questions should be raised concerning the distribution of that program's benefits over the medium term since recycling facilities built in the past would not be rewarded. Any investment subsidy raises the difficult issue of input mix. The same plant and equipment are used to recycle prompt waste, which does not require subsidization, and post consumer waste, with some prompt nearly always being used with PCW in a production process. The desirable mix from an efficiency standpoint is flexible with regard to availability, price, and conditions in other industry sectors. Despite these equity and administrative problems, some subsidy to waste processing equipment may be desirable in specific instances, for instance to municipally-related systems.

The incremental cost per ton for recycling shown in Table VIII-2 may be compared with collection and disposal expenses for a first cut at a cost/benefit analysis. Collection and disposal costs for solid waste vary widely, the former from \$15 to about \$32 ton and the latter from about \$1 to \$15 per ton. Midwest Research Institute used an average of \$25 for the combination.¹⁶ The Council on Environmental Quality indicates:

Roughly 75 percent or more of municipal solid waste disposal spending is for collection and the remainder for disposal. Disposal costs can range from \$1.00 to \$3.00 per ton for sanitary landfill and from \$3.00 to \$10.00 for incineration. Collection costs average roughly \$15.00 per ton, although they vary widely.

In heavily population urban areas, collection can go even higher. For example, in New York City costs ran to \$32.00 per ton in 1969, not including many employee benefits and depreciation.¹⁸

Resource Planning Associates estimates that landfill disposal costs are in the range of \$4.00 to \$8.00 per ton and incineration costs \$10.00 to \$15.00 per ton.¹⁹

While collection and disposal costs are high, they are lower than the direct government subsidy expenditure per incremental recycled ton in Table VIII-2. Even at a 30 percent recycling rate, the cost per incremental ton is \$46, higher than collection and disposal costs in the vast majority of cities. The difference is even less favorable to subsidized recycling when one considers that for major recycling increases municipal collection might still be employed, perhaps with increased direct collection costs derived from waste segregation. The economics of most current home separation schemes rely on "free" labor of the consumer.

The implication of this rough benefit cost analysis, including only direct costs, for our second hypothesis in Chapter I is clear. We revise our second hypothesis as follows:

Government intervention in the "market" process by any of the subsidies investigated in this dissertation is not justified from a direct economic cost/benefit viewpoint.

The only exception to the above could be medium term subsidization of specific new waste pulping facilities. Although subject to the equity questions raised earlier, such a program could provide an acceptable cost per incremental ton in certain geographical areas. Given contextual factors and the difficulty of supplying major 100 percent recycle plants, such programs might be expected to benefit smaller, non-integrated firms with major pulp supply problems. Support might be found from those societal segments encouraging competition and small business. Subsidization of waste pulping facilities only might encourage development of market secondary pulp, but substantial further study would be necessary to assess the feasibility of such a market.

Of course there are less specifiable aspects to the recycling subsidy issue than our cost/benefit analysis

reveals, including: reduction of solid waste pollution; income transfer from the federal government to municipalities and private firms; shifting of employment to urban areas; increase in low skill sorting and collection oriented activities; and preservation of virgin resources in a more natural state. As to the last point, it should be noted that virgin fiber may be considered a crop; i.e., we do not consider the harvesting of wheat an environmental degradation. Forest appearance and usage may be more efficiently enhanced by direct regulation of forest management practices than by increasing recycling. In sum, the non-market factors do not present such a strong case as to over-ride our revised hypothesis that federal intervention via the subsidies analyzed is not justified. While it would be interesting to compute the value of reduced paper solid waste pollution, we assert the difficulty of that task and the presumption that any computed figure would vary substantially by location.

The implications of our analysis are:

1. A positive financial subsidy designed to pass back to recyclers a portion of reduced collection and disposal costs would be very expensive in windfall terms for the additional recycling generated in most locations.
2. The converse to #1 is that a tax on virgin manufacture, while not having a high budgetary cost, would aggravate the current capacity cycle by lowering cash flow and by postponing new virgin capacity until prices had risen all the more substantially. Further, its impact on recycling would be less than a financial comparison would indicate as a result of the contextual factors explored in this study.
3. More recycling per dollar of budgetary cost may be expected for those government actions which take the context of industry specifically into account. One example is the recent GSA purchasing specification.

Thus, while the subsidies this study investigated are not justifiable, there may be justifiable actions the federal government should take concerning recycling of paper solid waste. These possible efficient actions

are centered around: 1) improving the contextual interface between paper firms and post consumer waste sources to increase factor mobility in the industry; 2) developing and distributing information on recycling methodology; and 3) taking advantage of what could be a decreasing industry cost phenomenon.

The first set of possibilities, improving the contextual interface and using the context of the industry as an aid to efficient subsidy design is very significant. The GSA purchasing subsidy is much more effective than its dollar cost would imply because the capital intensive vertical chain is critically concerned with maintaining the flexibility to use the government market in times of low operating rates. We would recommend that government actions such as the recently initiated GSA purchasing specification be based on the recycle percentage within a firm's total production of a product, rather than for specific batches, in order to use the industry's logistical efficiency. In working to make waste paper sources an acceptable fit with integrated industry context, we must be concerned with permanence of supply (virgin competition is almost completely permanent), predictable quality (virgin competition is completely predictable in quality), and a social context compatible enough with the major segments of the industry so that they will be encouraged to integrate backward (ownership or control) into paperstock. Municipal control of paperstock is one reasonable possibility, although "municipal gangsterism" is a term heard more than once by this author in interviews with paper firm executives. If a municipal collection system were to guarantee supply quantity and quality, and provide a reasonable social interface, the way would be open for backward integration. One possibility (emulating Big Box) would be for a municipality to sell a long term contract to deliver a certain tonnage weekly. The purchasing paper firm could then use the supply itself or sell it on the market, depending on logistics and firm needs, just as with virgin fiber (or as Big Box does with secondary fiber). Another possibility, subject to a feasibility study, would be for a municipality to sell merchant pulp made to order and truck it wet to nearby private recycling plants. Segregated waste paper might be pulped to order or fiber from vats of different types of secondary pulp might be mixed to order. This would tend to benefit non-integrated paper firms who might otherwise not be able to remain in business.

Federal aid in certain cases could offer greater leverage per dollar of expenditure by getting on the recycling learning curve.

Thus, the provision of federal assistance to municipalities in specific instances where collection, disposal, and solid waste pollution costs are particularly high may be justifiable, particularly if this assistance is aimed to dovetail with industry context. Such assistance might take the form of construction or demonstration grants for municipal recovery systems. Municipalities experiencing very high disposal or pollution costs should be willing to pass some of their savings to recycling firms which use the collected waste. If lack of understanding of the appropriate mechanism (long term contracts and/or industry interface) is a problem, the federal government should consider providing a benefit-in-kind information and assistance subsidy.

The structural context of the paper industry yields low research levels, with process and production orientation favoring marginal improvements in virgin technology. The steeper shape of secondary learning curves argues that government sponsored research and its dissemination in recycling technology and social context might prove very efficient per dollar of cost since it could overcome contextually determined lack of information.

The decreasing industry cost argument could be used to support federal aid to municipal separation systems which would benefit from sales of paper, glass, iron, steel, and aluminum scrap. Perhaps lack of information, mobility, and a context which does not foster the investigation or marketing of such projects within municipal government have prevented more recycling efforts from coming to fruition.

Federal aid in overcoming municipality/paper firm contextual interface problems may be essential to significant recycling increases. There may be many medium sized cities where newer technology, smaller recycling operations could be successful given comprehensive municipal collection. Both these municipalities and the larger paper firms may lack the understanding and contextual compatibility to bring such a combination about without outside assistance.

A further major implication for federal government policy concerns the impact of strategic context in dominant vertical industries on resource allocation in our society. Structural context has made it very difficult for paper firms to diversify, thus trapping resources (retained

earnings) where they are not allowed to seek out the highest risk adjusted return (presumably the basis for capitalist society). Steps should be examined which encourage these resources to find their most profitable use. Professor Scott suggests special concessions, perhaps exceptions to the anti-trust laws, to push dominant verticals toward diversifying acquisitions which could improve their one track performance.²⁰

Implications for Business Policy

Our research provides several implications for business policy. They concern principally: the need to consider explicitly the impact of structural context on investment decision making and cyclicity in integrated firms; the importance of strategic, structural, and social contexts in effecting the recycling decision; and the probable decrease in industry concentration with increased recycling.

Industry organizational context in which structure followed fashion has created a potentially unstable situation within the integrated chain where functional relationships are not explicitly recognized because of product divisional labels. This has been shown to aggravate capacity cycles and lower overall returns. We recommend explicit recognition of functional relationships within the integrated chain (even if unrelated divisions are still treated as product divisions) and overall policy planning as an integrated chain with the requirement that planning for change in any chain element explicitly recognize later impacts on all other chain elements.

Organizational and social contexts have hampered significant entry by the major firms into recycling. If direct subsidies become law, or even in the case that federally sponsored research makes recycling more economically attractive, the advantages may pass to smaller, less prestigious firms better able to work at the paperstock or municipality interface. Either larger firms alter their organizational context by treating paperstock in the logistically efficient manner they do virgin fiber, and improve the ability of their social context to better match the PCW supply source interface, or any recycling increases will lower industry concentration since smaller firms will be more inclined to respond. Given the industry characteristics discussed in Chapter IV, this implies lowered profits in the industry.

Limitations of the Research

Before discussing implications for further research, we shall briefly review the limitations of this research. These limitations include:

- 1) small number of sample firms from which balance sheet and income statement data was gathered;
- 2) selection of the sample firms on a judgment, time, and cooperation dependent basis;
- 3) ability to examine only three sub-industries on a financial basis because of time and money constraints;
- 4) difficulty in comparing data across the small number of sample firms in each sub-industry to reach a generalizable results;
- 5) rapidly changing price and cost environment in which the study took place; and
- 6) potential bias in discussions with sample firms resulting from their desire to influence government policy in certain directions.

Implications for Further Research

Several areas have been identified where further study is warranted:

- 1) Policies to encourage backward integration by major paper firms into paperstock in order to utilize large firms' logistical and management expertise and to put them on the recycling learning curve.
- 2) The paperstock market and the character of its participants. This market should be better understood before government action is taken concerning its interface with paper firms.
- 3) The mechanisms of technological change and information transfer within the virgin and recycle segments. Our research shows that industry perceptions often do not relate to the latest recycling technology. Such study might lead to a benefit-in-kind subsidy involving recycling technology information.

- 4) Inclusion of other paper grades in a study similar to this, such as construction board, news, and printing.
- 5) The municipal recovery system/paper industry interface and mechanisms for improving it.
- 6) Case studies of the decision to integrate backward into paperstock (for instance, Big Box).
- 7) Mechanisms enabling capital resources to escape from vertically integrated firms.
- 8) The nature and causes of cyclicity in the paper industry.
- 9) The feasibility of selling secondary market pulp, perhaps produced to order by municipalities.
- 10) Mechanisms to identify specific instances when a subsidy to plant and equipment is justifiable, and the means for implementing that subsidy.
- 11) The timber tax subsidy and its full impact on the recycling decision.
- 12) Tax incentives for paperstock designed to balance the timber tax subsidy.

FOOTNOTES

Chapter I

1. U.S. Department of Commerce, Bureau of the Census, "Current Industrial Reports," Series M 26 A (13), 1972.
2. Ibid.
3. See Chapter III and Appendix III for a description of calculations and assumptions.
4. This figure is lower than appears elsewhere because:
1) the Census Bureau shows waste paper consumption at 10,996,514 tons, while the American Paper Institute (API) shows 12,223,000 tons; 2) we define recycling rate as percentage of fiber inputs that are waste paper or board, whereas often recycling ratios show inputs divided by production output; and 3) this recycling rate does not discount for technical feasibility. The reader is referred to Appendix III for a comprehensive discussion of statistical differences.
5. Resource Planning Associates, Assessment of Alternative Financing Methods for Solid Waste Facilities and Equipment. Resource Planning Associates, 1973. Vol. I.
6. Ibid. This is in line with estimates from other sources. Midwest Research Institute in Paper Recycling: The Art of the Possible 1970-1985. New York: American Paper Institute, 1973 uses \$25/ton for 1970 collection and disposal costs (p. 120). The Council on Environmental Quality (CEQ) in The Second Annual Report of the Council on Environmental Quality, August 1971, p. 153, indicates that "Roughly 75 percent or more of municipal solid waste disposal spending is for collection and the remainder for disposal. Disposal costs can range from \$1.00 to \$3.00 per ton for sanitary landfill and from \$3.00 to \$10.00 for incineration. Collection costs average roughly \$15.00 per ton, although they vary widely. In heavily populated urban areas, collection can go even higher. For example, in New York City, costs ran to \$32.00 per ton in 1969, not including many employee benefits and depreciation."

7. The impact of any incentives is expected to be reflected in new plant and equipment because the choice of virgin versus secondary input is normally a pre-construction decision important in determining location.
8. Joseph Bower, Managing the Resource Allocation Process: A Study of Corporate Planning and Investment. Boston: Harvard University, Division of Research, 1970.
9. Robert W. Ackerman, Organization and the Investment Process: A Comparative Study. Unpublished doctoral dissertation. Graduate School of Business Administration, Harvard University, 1968.
10. This attempt is embarked upon with trepidation realizing the difficulty Meyer & Glauber had in explaining investment policy using simple statistics. See John R. Meyer and Robert R. Glauber. Investment Decision, Economic Forecasting and Public Policy. Boston: Division of Research, Harvard Business School, 1964.
11. See Jesse Markham, Competition in the Rayon Industry. Cambridge: Harvard University Press, 1952 for a stylistic ideal in conveying "feel" in a scholarly research report.
12. Ackerman, op. cit.
13. Alfred D. Chandler, Strategy and Structure. Cambridge, Mass: M.I.T. Press, 1961.
14. Bower, op. cit.
15. Richard Rumelt, Strategy, Structure and Economic Performance. Unpublished doctoral dissertation. Graduate School of Business Administration, Harvard University, 1972.
16. Bruce R. Scott, "Stages of Corporate Development" Harvard Business School teaching note. Cambridge, Mass.: President and Fellows of Harvard University, 1971.
17. Ackerman, op. cit.

18. The 18% tax credit on input represents the smallest subsidy recommended by a member of the paper industry, to this author's knowledge. The recommendation appears in Hugh Moore, "PSI Speaker Hugh Moore Calls for Tax Incentives to Foster Greater Use of Solid Waste Materials" in Secondary Raw Materials, Vol. II., No. 4, April 1973, pp. 192-200. p. 198. Also recommended, in Moss bill, House 818 (93rd Congress, 1st Session).

Chapter II

1. U.S. Congress, Joint Economic Committee, The Economics of Federal Subsidy Programs. Washington, D.C.: U.S. Government Printing Office, 1972. pp. 26, 31.
2. Ibid., p. 42.
3. Otto Davis and Morton Kamien, "Externalities, Information, and Alternative Collective Action" in Robert and Nancy Dorfman, editors, Economics of the Environment. New York: Norton & Co., 1972, pp. 69-87.
4. Ibid., p. 71.
5. See Dorfman and Dorfman, op. cit. "Introduction" for an expansion of a similar point.
6. O. Davis and M. Kamien, op. cit., p. 72.
7. Ibid.
8. U.S. Congress, Joint Economic Committee, op. cit. p. 44.
9. Ibid., p. 45.
10. Ibid.
11. Ibid.
12. Ibid.
13. Ibid.
14. Guido Calabresi, "Transaction Costs, Resource Allocation, and Liability Rules" from the Journal of

Law and Economics, April, 1968 as reprinted in Economics of the Environment, op. cit., pp. 194-201.

15. Where the definition of transaction is extended to include the cost of excluding freeloaders.
16. Guido Calabresi, op. cit., p. 196.
17. Ronald Coase, "The Problem of Social Cost," excerpted from the Journal of Law and Economics, October, 1960 for Economics of the Environment, op. cit., pp. 100-129. p. 116.
18. A.C. Pigou, The Economics of Welfare, (4th edition, 1932, p. 183) as quoted in Coase, op. cit., p. 116.
19. Ralph Turvey, "On Divergences between Social Cost and Private Cost" from Economica, August, 1963 as reprinted in Economics of the Environment, op. cit., pp. 130-134.
20. Coase, "The Problem of Social Cost," op. cit.
21. Davis and Whinston, "Externalities, Welfare, and the Theory of Games," Journal of Political Economy, June, 1962.
22. Buchanan and Stubblebine, "Externality," Economica, November, 1962.
23. The reader is referred to Ralph Turvey, op. cit., for a full exposition of this point.
24. Allen Kneese and Blair Bower, "Causing Offsite Costs to be Reflected in Waste Disposal Decisions," from Managing Water Quality: Economics, Technology, Institutions, Johns Hopkins Press for Resources for the Future, Inc. as reprinted in Economics of the Environment, op. cit., pp. 135-154.
25. Turvey, op. cit.
26. Ibid., p. 134.
27. Calabresi, op. cit., p. 196.
28. Turvey, op. cit., p. 133.

29. Ibid., p. 134.
30. Coase, op. cit.
31. Calabresi, op. cit.
32. See Institute for Policy Analysis, "The Measurement of External Effects: A Critical Survey," preliminary draft, February, 1973 for an excellent discussion.
33. The Economics of Federal Subsidy Programs, op. cit. p. 42.
34. Ibid., p. 46.
35. United States Bureau of the Census, "Current Industrial Reports Series M 26 A (13)," 1971 preliminary figures.
36. Based on 1.84 tons of wood per ton of paper, the figure used for containerboard in Eileen Clausen, "Environmental Impacts of Packaging" U.S. Environmental Protection Agency, 1973.
37. Ibid., p. 47.
38. Emil M. Sunley, Jr., "The Federal Tax Subsidy of the Timber Industry" in The Economics of Federal Subsidy Programs by U.S. Congress, Joint Economic Committee, op. cit., part 3, pp. 317-342, p. 317.
39. Ibid., p. 317.
40. Ibid., p. 327.
41. Ibid., p. 317.
42. Ibid., p. 328.
43. The Revenue Act of 1943 was passed by overturning a presidential veto. President Roosevelt indicated the bill provided benefits "not for the needy but for the greedy" and that "as a grower and seller of timber: he thought: "...timber should be treated as a crop and therefore as income when it is sold." U.S. Congress, House, Message from the President of the United States. H.Doc. 443, 78th Congress, Second session, 1943, pp. 1-3.

44. Sunley, op. cit., p. 330.
45. M.S. Mighdoll, National Priorities for Recycling: Proposals for a Legislative Action Program, a statement made before the Fiscal Subcommittee of the Joint Economic Committee of Congress, Washington, D.C., November 8, 1971.
46. See Resource Planning Institute, Raw Materials Transportation Costs and Their Influence on the Use of Wastepaper and Scrap, for U.S. Environmental Protection Agency, Cincinnati, Ohio, 1973 for summary.
47. Ibid., and Moshman Associates. "Analysis of Transportation Rates and Costs for Selected Virgin and Secondary Commodities." Final Report to U.S. Environmental Protection Agency, Office of Solid Waste Management and Practice, under Contract No. 68-01-0790 (September, 1973).
48. Ibid., p. 149.
49. U.S. Environmental Protection Agency, Office of Solid Waste Management Programs. Second Annual Report to Congress on Resource Recovery and Source Reduction. Washington, D.C.: U.S. Government Printing Office, 1974, p. 28.
50. Ibid.
51. Senate 1593 (93rd Congress, 1st Session).
52. House 818 (93rd Congress, 1st Session).
53. House 9467 (93rd Congress, 1st Session).
54. Senate 1879 (93rd Congress, 1st Session).
55. Hugh R. Moore, President of Bergstrom Paper Company (fine white), "PSI Speaker Hugh Moore Calls for Tax Incentives to Foster Greater Use of Solid Waste Materials" in Secondary Raw Materials, Vol. II, No. 4, April, 1973. pp. 192-200. p. 198, recommends a tax credit of 18% for PCW paper. John Rich, President of Garden State Paper Company (newsprint recyclers) recommended a 50% extra tax deduction (letter to Resource Planning Institute, December 8,

1972).

56. American Paper Institute, "Portion of the Testimony of the American Paper Institute Before the Committee on Ways and Means of the House of Representatives on Recycling for Waste Paper March 6, 1973." New York: American Paper Institute, 1973.
57. Definition by Midwest Research Institute, op. cit. p. 220 accepted by the American Paper Institute, Ibid.
58. American Paper Institute testimony 3/6/73, op. cit.
59. Ibid.
60. Midwest Research Institute, op. cit., p. xvii as quoted in American Paper Institute Testimony, op. cit.

Chapter III

1. American Paper Institute, Wood Pulp Statistics 36th Edition, p. 56.

Chapter IV

1. See John Lintner, "The Valuation of Risky Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets." Review of Economics and Statistics, February, 1965.
2. Joseph Bower, op. cit., p. 23. Bower later admits the possibility that the portfolio model may be readonably applied to some conglomerates, p. 293.
3. Joseph Bower, op. cit., Chapter 2.
4. Joseph Bower, op. cit., p. 50.
5. Ibid., p. 75.

6. Ibid., p. 76.
7. Ibid., p. 68.
8. Ibid.
9. Yair Aharoni, The Foreign Investment Decision Process. Unpublished doctoral dissertation, Harvard University Graduate School of Business Administration. Cambridge, Massachusetts, 1968, pp. 123-124, as quoted in Bower, op. cit., p. 68.
10. Bower, op. cit., p. 69.
11. Ibid., p. 59.
12. Ibid., p. 71.
13. Ibid., p. 71.
14. Alfred D. Chandler. Strategy and Structure, op. cit.
15. Bruce R. Scott, "Stages of Corporate Development: A Descriptive Model," op. cit.
16. Richard Rumelt, Strategy, Structure, and Economic Performance, op. cit.
17. Chandler, Scott, and Rumelt, op. cit.
18. Definitions are from Rumelt, op. cit. pp. 52-55, which are reproduced in Appendix VIII.
19. While the data in this exhibit suffers from methodological problems due to small sample size and Rumelt's treatment of firms which were acquired, it is consistent with the thrust of other evidence. Further, coverage ratios for SIC 26, Rumelt's industry classification, were as follows for 1963:

SIC	2611	71%
	2621	92%
	2647	97%
	2651	88%
20. Similar caveats are noted, as in 19, for interpretation of this exhibit.
21. Rumelt, op. cit., p. 171.

22. Ibid., p. 172.
23. Rubber and plastics were 80% in DV strategic in 1969 and 1949 according to Rumelt's sample, Ibid., pp. 180-181.
24. Chandler, op. cit.; Ackerman, op. cit.; Scott, op. cit.; Rumelt, op. cit.
25. F.T. Moore, "Economics of Scale: Some Statistical Evidence." Quarterly Journal of Economics 82 (2): 232-245. 1959.
26. Sales per dollar of capital for SIC 26 have moved as follows:

1926	.95
1945	1.44
1947	1.70
1955	1.42
1968	1.38

Much of the fluctuation may be in prices, but the post-war trend is down.

Source: Department of the Treasury, IRS, "Statistics of Income, Corporation Income Tax>Returns" in American Paper Institute, "A Capital and Income Survey", 1971, p. 17.

27. William Copeland. "Can Industry Afford to Build New Board Mills." Pulp and Paper, 47 (1): pp. 68-70. January 1973.
28. Ibid.
29. American Paper Institute, "The Statistics of Paper 1973," op.cit., p. 40.
30. William Copeland, op. cit. of MacKay-Shields Economics, Inc.
31. Ibid.
32. American Paper Institute, "Statistics of Paper," 1964, 1972.
33. Borje Steenberg, Address to API, March 1971.
34. Ibid.

35. Robert L. Nash, quoted in "pulpmen Blackball Commodity Market Idea." Pulp and Paper 45 (5): p. 67. May, 1971.
36. Steenberg, op. cit.
37. John F. Darrow, TAPPI, Vol. 49, No. 7, August 1972, p.1222.
38. Ackerman, op. cit., p. 84.
39. Report to the Committee on Interstate and Foreign Commerce, "Pulp, Paper, and Board Supply-Demand," House Report No. 693, 1973, p. 63.
40. Rumelt, op. cit., p. 252.
41. Ibid., p. 253.
42. Three of our sample firms, Big Box, Imperial, Universal, described in Chapter VI.
43. Smith Barney, "The Paper Industry - Another Decade of Disappointment?", May 18, 1973, and Paine, Webber, Jackson, and Curtis, "Industry Review the Papers - 1973 Outlook " (both published industry opinions), and Lawrence Ross of Mitchell Hutchins, Inc. to whom we are particularly indebted for a telephone conversation November 28, 1973 and for his excellent industry note "Review and Projections U.S. Pulp and Paper Industry 1972-1973" (New York, Mitchell Hutchins, Inc., March 1972). Mr. Ross suggested points c, d, e, and f in particular.
44. American Paper Institute, Wood Pulp Statistics 36th Edition, 1972, pp. 57, 81.
45. Ibid., pp. 28-34.
46. John Morse, "Rockford Containers (A)." Harvard Business School Case. Cambridge: President and Fellows of Harvard University, 1968, p. 3.
47. "Rockford Containers," op. cit.
48. Rumelt, op. cit., p. 262.

49. Statement of Dr. Joel Dirlam, Hearings Before the Senate Committee on the Judiciary, Subcommittee on Antitrust and Monopoly, Economic Concentration, Washington, D.C., Government Printing Office, 1965, Part 2, p. 767, as quoted in Rumelt, op. cit. p. 262.
50. Rumelt, op. cit., p. 251.
51. Ibid., p. 252.
52. Ibid., p. 257.
53. Alfred Chandler, Strategy and Structure, op. cit.
54. John K. Galbraith, The New Industrial State, Boston: Houghton Mifflin 1971.
55. Rumelt, op. cit., p. 265.
56. Ibid.
57. A division where profits, rather than just costs, are measured.
58. Scott, op. cit.
59. Chandler, op. cit.
60. Scott, op. cit.
61. Ibid., p. 10.
62. Ibid., pp. 22-23.
63. Rumelt, op. cit.
64. See Appendix XXX for Rumelt's full definitions.
65. Chandler, op. cit. from Rumelt, op. cit., p. 112.
66. Scott, op. cit., p. 24.
67. Rumelt, op. cit., p. 264.
68. Ackerman, op. cit., p. 367.

Chapter V

1. See Chapter VI for a fuller explanation.
2. Midwest Research Institute, op. cit., p. 112.
3. Ibid.
4. David C. Clark. "Secondary Fiber Problems in a Tissue Mill." TAPPI. "n.d."
5. William Martin, "Garden State's Philosophy of Secondary Fiber Quality" in TAPPI. 4th Secondary Fiber Conference 1971.
6. Ibid.
7. Arthur Claghorn, TAPPI 12th De-Inking Conference," 1967. p. 43.
8. Arthur D. Little, "New Fiber Separation Process Gives Recycled Strength Equal to Virgin Board." Paperboard Packaging, Vol. 58, April, 1973.
9. Claghorn, op. cit.
10. Ibid.
11. Ibid.
12. Ibid., p. 43.
13. See Midwest Research Institute, op. cit., p. 101.

Chapter VI

1. Ackerman, op. cit., p. 75.
2. Ibid.
3. Ibid.
4. Ibid.
5. Ibid., p. 76.

6. The unit even includes a concrete plant acquired with a lumber mill.
7. Ackerman, op. cit., p. 81.
8. See Ackerman, op. cit.
9. Neil W. Chamberlain, The Firm: Micro-Economic Planning and Action. New York: McGraw-Hill, 1962, p. 278 as quoted in Ackerman, op. cit., pp. 381-382.
10. Ibid., p. 382.
11. Ackerman, op. cit., pp. 333-334.
12. This is part of Ackerman's Revised Hypothesis C in Ackerman, op. cit., p. 358.
13. Ibid.
14. Ibid., p. 133.
15. Ibid.
16. Author's research and Ackerman, Ibid., p. 333.
17. Ackerman, op. cit., p. 347.
18. Ibid., p. 320.
19. Ibid., p. 128.
20. Ibid.
21. Ibid., p. 143.
22. Ibid., p. 368.
23. National Academy of Sciences, 1970 as cited in Midwest Research Institute, op. cit., p. vii.
24. Quoted in a Big Box annual report which we do not cite for reasons of disguise.

Chapter VII

1. See Samson G. Tuchman, The Economics of the Waste Paper Industry. Doctoral dissertation at New York University, 1963, published by University Microfilms, Ann Arbor, Michigan, #64-1781.
2. Ibid., p. 133.
3. Ibid.

Chapter VIII

1. Bruce Scott, "The New Industrial State: Old Myths and New Realities," Harvard Business Review, Vol. 51, no. 2, March-April, 1973, pp. 133-148 discusses this problem not in the context of recycling, suggesting relaxation of anti-trust laws for dominant verticals as a possible solution.
2. William Tye, "The Capital Grant as a Subsidy Device: The Case Study of Urban Mass Transportation" in Joint Economic Committee, op. cit.
3. American Paper Institute, "Capacity 1972-1975, Paper, Paperboard, Wood Pulp." American Paper Institute, 1973.
4. Ibid.
5. Ibid., pp. 14-15.
6. Ibid., pp. 12-13.
7. Ibid., p. 7.
8. Midwest Research Institute, op. cit., p. vi.
9. See, for instance, H.R. Josephson, "Recycling of Waste Paper in Relation to Forest Resources," TAPPI, Vol. 54, No. 6, June, 1971, pp. 896-899.
10. Borje Steenberg, "Future Technical Needs and Trends of the Paper Industry," TAPPI, Vol. 56, No. 5, May, 1973, pp. 60-62.

11. Fred Ianazzi of Arthur D. Little, Inc. Telephone conversation November 28, 1974.
12. Benjamin Slatin, "Fiber Requirements of the Paper Industry in the 70's and 80's." Multi Plyboard Joint Conference - Secondary Fiber, September 14-17, 1971.
13. Calculated from American Paper Institute, Wood Pulp Statistics, 36th Edition, N.Y. American Paper Institute, 1972, p. 58.
14. Arthur D. Little, Can Federal Procurement Practices Be Used to Reduce Solid Waste, op. cit., p. 97.
15. Paper Recycling, the Art of the Possible, op. cit.
16. Ibid., p. 120.
17. Ibid., p. 25.
18. Council on Environmental Quality, The Second Annual Report of the Council on Environmental Quality August 1971, p. 153.
19. Resource Planning Associates, Assessment of Alternative Financing Methods for Solid Waste Facilities and Equipment. Resource Planning Associates, Cambridge, Massachusetts, 1973.
20. Bruce Scott, "The New Industrial State: Old Myths and New Realities," op. cit.

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GLOSSARY

Basis Weight. Weight in pounds of paper or board in its basic size.

Bleaching. The process of chemically treating pulp to alter the coloring matter so that the pulp has a higher brightness. This is usually accompanied by partial removal of noncellulosic materials. The two classes of chemicals used are oxidizing agents (such as chlorine, hypochlorites, chlorine dioxide, and hydrogen peroxide) and reducing agents (such as sulfur dioxide and hydrosulfites). Bleaching may be carried out in a single stage but most processes use sequences of several stages.

Bogus. A descriptive term applied to papers and paperboards manufactured principally from old papers or inferior or low-grade stock in imitation of grades using a higher quality of raw material.

Break. A term used to denote a complete rupture of a web of paper or paperboard during manufacture or some subsequent operation which utilizes rolls of paper. Such breaks are generally spliced and marked by a protruding flag.

Breast Roll. A large diameter roll around which the fourdrinier wire passes at the machine headbox just at or ahead of the point where the stock is admitted to the wire by the stock inlet. It is covered with corrosion-resistant metal or fiberglass and is usually driven by the fourdrinier wire.

British Thermal Unit (BTU). The unit of heat required to raise the temperature of 1 pound of water 1°F at or near 39.2°F. In resource recovery, the term is used to indicate the amount of heat energy available in a given amount of waste or recovered fuel.

Broke. Paper that has been discarded anywhere in the process of manufacture. "Wet broke" is paper taken off the wet press of a paper machine; "dry broke" is made when paper is spoiled in going over the driers or through the calendars, trimmed off in the rewinding or rolls, trimmed from sheets being prepared for shipping, or discarded for manufacturing defects. It is usually returned to a repulping unit for reprocessing.

Burst Factor. A numerical value obtained by dividing the bursting strength in grams per square centimeter by the basis weight of the sheet in grams per square meter.

Bursting Strength. A measure of the ability of a sheet to resist rupture when pressure is applied to one of its sides by a specified instrument, under specified conditions. It is largely determined by the tensile strength and extensibility of the paper or paperboard. Testing for bursting strength is very common although its value, except for limited, specific purposes is questionable. See also Burst factor, Points per pound.

Calender. A set or "stack" of horizontal cast-iron rolls with chilled, hardened surfaces, resting one on the other in a vertical bank at the end of the paper machine. The paper is passed between all or part of these rolls to increase the smoothness and gloss of its surface.

Capacity. The capacity of a machine is the output expressed in pounds or in tons per day when under full operation. The actual output, usually advanced for a period of a week, month, or longer, multiplied by 100 and divided by the capacity, gives the per cent of capacity.

Chip. (1) A term used to designate a paperboard made from paper stock--usually mixed papers. (2) A small piece of wood produced by a chipper in a form suitable for processing into wood pulp.

Combination Board. A general term designating a board made on a cylinder machine wherein one or both of the outer plies are of a different raw material and/or color than the middle ply, whereas a plain or solid board has the same material throughout. Where three stocks are used, or where two outside liners of the same stock are vat lined onto a filler of a different stock, this is customarily indicated in the name of the board. Buff patent-coated news, white patent-coated news, bleached manila-lined chip, etc., indicate two different kinds of stock in each board and also indicate but one liner. This is also indicated by the words "single lined," either together at the end of the board name or separated; bleached manila-lined chip, single-lined or single bleached manila-lined chip both

mean chip center and back, vat lined with one liner of bleached manila furnish. However, bleached manila-lined chip means exactly the same thing. When the top and bottom liners of a board are both of the same kind of stock, this is indicated by the words "double-lined" or "double". Colored liners are more or less definitely indicated in the name of the grade. Most boxboards and many paperboard grades are combination boards.

Consistency. The percentage, by weight, of airdry (or oven-dry) fibrous material in a stock or stock suspension. It is also called density or concentration.

Container Board. A general term designating: (1) solid fibre or corrugated combined board used in the manufacture of shipping containers and related products; (2) the component materials used in the fabrication of corrugated board and solid fibre combined board: Linerboard; Corrugating medium; Chipboard.

Context. Set of environmental forces that influence the process of investment definition and impetus.

Converter. A plant which manufactures paper products, such as papeteries, envelopes, bags, containers, coated paper, gummed paper, etc. Such operations are frequently carried out by primary paper and board manufacturers as well as by independent companies not engaged in primary manufacturing.

Converting Mill. A nonintegrated paper or board mill, i.e. one which does not produce its own pulp.

Corrugating. The imparting of a wavelike shape to a paper or a board. It is carried out on a corrugating machine by moistening or steaming a roll of corrugating medium prior to passing it between two metal rolls cut with alternate ridges and grooves which are geared to run in complement to each other. This impresses permanent parallel flutes in the paper at right angles to the machine direction.

Couch Roll. This term refers to a roll primarily involved in dewatering and picking off, or couching, of the newly formed paper web from the wire on which it was formed and partially dewatered and in the transfer of the web to the wet press felt for further dewatering. (1) On a Cylinder Machine the couch roll runs

against the top of the sheet-forming cylinder mold to produce a pressure nip through which the pick-up felt passes. The sheet formed on the cylinder passes up and through this nip for further dewatering by the nip pressure, is picked off the wire mesh surface of the cylinder mold by the pickup felt, and may be joined by additional plies picked up in turn from other cylinder molds as it is transported by the felt to the wet presses. (2) On a Fourdrinier Machine either a suction couch roll or a pressure couch is used. The suction couch roll consists of a heavy metal shell drilled with many small holes through which a suction box inside this shell can apply a high vacuum for rapid removal of water from the sheet as it is carried by the wire over this roll immediately prior to its transfer from the wire to a felt for passage through the wet presses. The pressure couch consists of a pair of rolls forming a pressure nip through which the wire and partially dewatered sheet pass for further water removal by pressure immediately prior to transfer of the sheet from the wire to the wet press felt. The two rolls involved are termed top couch roll and bottom couch roll.

Creasing Strength. The property of a sheet to retain its tensile strength after folding and creasing under a specified load.

Creep. The dimensional change with time of the material under constant load following the initial "instantaneous" elastic rapid deformation. Because of the practical difficulty of separating the instantaneous elastic deformation from the delayed deformation, creep is often taken as the total deformation including the "instantaneous" deformation. The phenomenon embraces the partial recovery toward the initial dimensions when the force is removed. Creep at room temperature is sometimes called cold flow.

Crimp. (1) To increase or break the grain in a sheet of paper so that it will lie flat, as to crimp the binding edge of sheets for looseleaf binders. (2) A synonym for creped.

Curl. Curvature of the sheet. It may appear as a gross curl around some direction in the sheet, e.g., the machine direction, or as an uneven warping of the edges of the sheet. Curl is caused by asymmetry within the sheet, such as the nonuniform distribution

of moisture components, internal stresses, etc. Also, fiber orientation has an influence on the direction and magnitude of curl.

Cylinder Machine. One of the principal types of paper-making machines, characterized by the use of wire-covered cylinders or molds on which a web is formed. These cylinders are partially immersed and rotated in vats containing a dilute stock suspension. The pulp fibers are formed into a sheet on the mold as the water drains through and passes out at the ends of the cylinders. The wet sheet is couched off the cylinder onto a felt, which is held against the cylinder by a couch roll. A cylinder machine may consist of one or several cylinders, each supplied with the same or different kinds of stock. In the case of a multicylinder machine, the webs are successively couched one upon the other before entering the press section. This permits wide variation in thickness or weight of the finished sheet, as well as a variation in the kind of stock used for the different layers of the sheet. The press section and the dry end of the machine are essentially the same as those of other types of machines. See Fourdrinier machine for description of the dry end of the machine.

Diversity. Herein refers to range of output by different SIC codes.

Divisional. An organizational structure that consists of a central office and a group of operating divisions, each having the responsibility and resources needed to engineer, produce and market a product or set of products.

Divisional Interdependence. Amount of business interaction required among divisions of a corporation. Vertically integrated companies who have adopted a divisional structure have much greater divisional interdependence than conglomerates.

Elasticity. That property of a material which enables it to undergo deformation and to recover its original dimensions after removal of the deforming stress. Elasticity is determined more by ability to recover initial shape than by capacity to be deformed or extended. It should not be confused with Extensibility or Stretch.

Extensibility. The capacity for extension (extension being the increase in length per unit length). Rubber affords a good example of great extensibility. See Stretch.

Felt. A continuous belt generally made of wool but frequently of a combination of two or more of the following fibers: wool, cotton, asbestos, and synthetic fibers. Felts perform the function of mechanical conveyors or transmission belts, provide a cushion between the press rolls and serve as a medium for the removal of water from the wet sheet.

Fiber. The unit cell of vegetable growth which is many times longer than its diameter and which is the unit of paper pulps. Fibers are sometimes divided into two classes, bast and wood, but they are best designated by means of the tissue or region in which they occur, as cortical fibers, pericyclic fibers, phloem fibers, wood fibers, leaf fibers, etc. Other types of fiber such as mineral, animal, and synthetic are also used to a certain extent in making special types of paper.

FIBERS

Roundwood. Comprises roundwood bolts and logs (4 feet or longer, including tree lengths) brought to the pulpmill for chipping or chips made from primary roundwood bolts and logs at a chipmill, remote from the pulpmill.

Forest Residues. Comprises chips, particles and fibers arising as by-products of logging operations including culled material, slash, limbs, saplings, etc. Also includes other secondary forest material not usually defined as logging residues such as tops, branches, standing saplings and cull trees, etc.

Manufacturing Residues. Comprises chips, particles and fibers arising from primary and secondary manufacturing (saw mills, plywood and veneer mills, flooring and furniture factories, etc.) including slabs, cores, edgings, shavings, sawdust, etc.

Other Fibers. Cotton linters, cotton linter pulp, textile mill waste and cuttings, rags, waste rope and cordage, bagasse, flax, straw, jute, esparto, kenaf and all other non wood fibers used in paper and paper-board manufacture.

Fiber Composition. The percentages of different types of fibers present in a sheet of paper or pulp. It is primarily determined by the anatomy of the fibers and secondarily by means of various staining reactions.

Fines. Very short pulp fibers or fiber fragments and ray cells. They are sometimes referred to as flour or wood flour.

Folding Endurance. The number of folds under specified conditions in a specified instrument which a specimen will withstand before failure. In the usual test, a specimen is subjected repeatedly to double folds through a wide angle while under tension.

Fourdrinier Machine. The fourdrinier machine, named after its sponsor, with its modifications and the Cylinder machine comprise the machines normally employed in the manufacture of all grades of paper and board. The fourdrinier machine, for descriptive purposes, may be divided into four sections, the wet end, the press section, the drier section, and the calender section. In the wet end the pulp or stock (at a consistency or concentration of 0.2 to 1%, depending upon the grade and weight of paper to be manufactured) flows from a headbox through a slice onto a moving endless belt of wire cloth, called the fourdrinier wire or wire, of brass, bronze, stainless steel, or plastic. The wire runs over a breast roll under or adjacent to the headbox, over a series of tube or table rolls or more recently drainage blades which maintain the working surface of the wire in a plane and aid water removal. The tubes or rolls create a vacuum on the downstream side of the nip. Similarly, the drainage blades create a vacuum on the downstream side where the wire leaves the blade surface, but also perform the function of a doctor blade on the upstream side. The wire then passes over a series of suction boxes, over the bottom couch roll (or suction couch roll) which drives the wire and then down and back over various guide rolls and a stretch roll to the breast roll. The second section, the press section, usually consists of two or more presses, the function of which is to mechanically remove further excess of water from the sheet and to equalize the surface characteristics of the felt and wire sides of the sheet. The wet web of paper, which is transferred from the wire to the felt at the couch roll, is carried through the presses on the felts, the texture and character of the felts varying according to the grade of paper being made. The third section, the drier section, consists

of two or more tiers of driers. These driers are steam-heated cylinders, and the paper is held close to the driers by means of fabric drier felts. As the paper passes from one drier to the next, first the felt side and then the wire side comes in contact with the heated surface of the drier. As the paper enters the drier train approximately one-third dry, the bulk of the water is evaporated in this section. Moisture removal may be facilitated by blowing hot air onto the sheet and in between the driers in order to carry away the water vapor. Within the drier section and at a point at least 50% along the drying curve, a breaker stack is sometimes used for imparting finish and to facilitate drying. This equipment is usually comprised of a pair of chilled iron and/or rubber surfaced rolls. There may also be a size press located within the drier section, or more properly, at a point where the paper moisture content is approximately 5%. The fourth section of the machine is known as the calender section. It consists of from one to three calender stacks with a reel machine. The purpose of the calender stacks is to finish the paper, i.e., the paper is smoothed and the desired finish, thickness or gloss is imparted to the sheet. Water, starch or other solutions, wax emulsions, etc., may be applied for additional finish. The reel winds the finished paper into a roll, which for further finishing either can be taken to a rewinder or, as in the case of some machines, the rewinder on the machine produces finished rolls directly from the machine reel. The wire, the press section, the several drier sections, the calender stacks, and the reel are so driven that proper tension is maintained in the web of paper despite its elongation or shrinkage during its passage through the machine. The over-all speed of the machine is determined by the grade and weight of paper being manufactured. There are two modifications of the fourdrinier in use, known as the Harper and the so-called Yankee or M.G. machine, which in principle are similar to the fourdrinier machine. Papers varying in weight from lightweight tissue to heavy paperboard are made on the fourdrinier machine.

Freeness. A measure of the rate with which water drains from a stock suspension through a wire mesh screen or a perforated plate. It is also known as slowness or wetness, according to the type of instrument used in its measurement and the method of reporting results.

Functional. An organizational structure in which major sub-units are defined in terms of business functions or stages in the manufacturing process.

Furnish. The mixture of various materials that are blended in the stock suspension from which paper or board is made. The chief constituents are the fibrous material (pulp), sizing materials, wet-strength or other additives, fillers and dyes.

Generic. Pertaining to a class of related things.

Headbox. (1) On fourdrinier machines: A large flow control chamber which receives the dilute paper stock or furnish from the stock preparation system and by means of baffles and other flow evening devices, maintains sufficient agitation of the mixture to prevent flocculation of the fibers, spreads the flow evenly to the full width of the paper machine and provides delivery of stock to the fourdrinier wire uniformly across its full width. (2) On cylinder machines: A flow-regulating device which controls the volume of stock flowing to the screens and mixing boxes before the vats.

Impetus. Herein, the force that moves a project toward funding.

Internal Rate of Return (IRR). That rate of discount which equates the present value of outflows and inflows.

Jute Board. (1) A paperboard for use in shipping containers. (2) A combination board for use in folding box manufacture, made on a cylinder machine wherein one or both of the outer plies are made of kraft or reclaimed kraft paper stock and the remainder of mixed paper stock. Although this is termed jute, it contains no jute fiber. The board must be able to withstand scoring and folding.

Lignin. The noncarbohydrate portion of the cell wall of plant material which is usually determined as the residue left on hydrolysis with strong acid of the plant material after resins, waxes, tannins, and other extractives have been removed. In the lignin determination, softwoods give from 26 to 34% lignin with a methoxyl content of about 21%. Lignin is an amorphous material of high molecular weight, predominantly aromatic in character, built up of

phenylpropane units, and contains the major portion of the methoxyl groups present in the plant material. Lignin is unhydrolyzable in acids, readily oxidizable, soluble in hot alkali and bisulfite, and readily condenses with phenol and with thio compounds. Lignin is not a compound, but is a system and varies in composition with method of isolation and with species, age, growing conditions, etc., of the tree or lignified material. Lignin is more or less completely removed during chemical pulping operations; in the alkaline processes it appears in the spent liquors as alkali lignin (and thiolignin in the kraft process); in the acid or neutral sulfite process, the lignin is sulfonated to lignosulfonic acids and occurs in the spent liquors as calcium, ammonium, magnesium, or sodium salts of these acids. No lignin is removed by mechanical pulping processes. Lignin is further removed or modified by bleaching sequences to give pulps of higher brightness. By-product lignin has found important uses as dispersing agents, oil well drilling mud additives, and as a commercial source of vanillin.

Morphology. Form and structure.

Mullen. An expression used to refer to bursting strength of a paper. It is so called from the name of the instrument used to make the burst strength test.

Opacity. The property of a sheet which obstructs the passage of light and prevents one from seeing through the sheet, objects on or in contact with the opposite side.

Outthrows. The term outthrows is used in the waste-paper industry to designate all papers that are so manufactured or treated or are in such form as to be unsuitable for consumption as the grade specified.

Paper. (1) (General terms). The name for all kinds of matted or felted sheets of fiber (usually vegetable, but sometimes mineral, animal or synthetic) formed on a fine screen from a water suspension. Paper derives its name from papyrus, a sheet made by pasting together thin sections of an Egyptian reed (*Cyperus papyrus*) and used in ancient times as a writing material. (2) (Specific term). One of the two broad subdivisions of paper (general term), the other being Paperboard (q.v.). The distinction between paper and paperboard is not sharp but, generally speaking, paper is lighter in basis weight, thinner, and more flexible than

paperboard. Its largest uses are for printing, writing, wrapping, and sanitary purposes, although it is also employed for a very wide variety of other uses.

Paperboard. One of the two broad subdivisions of paper (general term), the other being Paper (specific term) (q.v.). The distinction between paperboard and paper is not sharp but broadly speaking, paperboard is heavier in basis weight, thicker, and more rigid than paper. In general, all sheets 12 points (0.012 inch) or more in thickness are classified as paperboard. There are a number of exceptions based upon traditional nomenclature. For example, blotting paper, felts, and drawing paper in excess of 21 points are classified as paper while corrugating medium, chipboard, and linerboard less than 12 points are classified as paperboard. Paperboard is made from a wide variety of furnishes on a number of types of machines, principally cylinder and fourdrinier. The broad classes are: (1) Container board, which is used for corrugated cartons, (2) Boxboard which is further divided into (a) folding boxboard, (b) Special food board, (c) Set-up boxboard, and (3) all other special types such as Automobile board, Building board, Tube board, etc.

PAPER GRADES

Newsprint. Paper made largely from groundwood pulp, used chiefly in the printing of newspapers.

Groundwood, Uncoated. Uncoated papers containing more than 25% groundwood fiber in their furnish, excluding newsprint.

Machine and Off Machine, Coated. Bleached papers with a coating weight of at least 2-1/2 pounds (25 x 38 - 500) on either side and at least 50% of the coating consisting of pigment.

Book Paper, Uncoated and Chemical Writing. Bleached uncoated printing and writing papers containing not more than 25% groundwood pulp in their furnish; i.e., offset, tablet, envelope, business papers (bond, ledger, mimeo, duplicator), form bond, cover and text and related papers.

Bleached Bristols. Includes tabulating index, tag and file folder, coated cover bristols, and uncoated bristols (index, printing, and postcard).

Cotton Fiber: Papers containing 25% or more in their furnish of cotton, cotton rags, cotton waste, linters, linter pulp, flax, or similar fibers.

Thin Papers. Includes carbonizing, condenser, cigarette, and similar thin specialties.

Packaging and Industrial Converting. Wrapping paper, shipping sack, bag and sack other than shipping sack, and other converting papers--18 pounds and over.

Unbleached Kraft. Paper containing more than 50% unbleached sulphate wood pulp.

Other Packaging and Industrial Converting. Paper used for these purposes and containing more than 50% bleached wood pulp, also includes glassine, grease-proof, and vegetable parchment.

Special Industrial. Paper and board, of all weights, calipers and furnishes, designed for specialized end uses, such as abrasive paper, absorbent paper, cable paper, electrical insulation, vulcanized fiber, resin-impregnating stock, and similar grades. It does not include wet machine board.

Tissue. Includes sanitary grades; i.e., toilet, facial, napkin, toweling, sanitary napkin, wiper and special sanitary papers, and waxing, wrapping, wadding and miscellaneous grades.

PAPERBOARD GRADES

VIRGIN:

Unbleached Kraft Paperboard. Paperboard made from a furnish containing not less than 80% wood pulp produced by the kraft sulphate process.

Linerboard. Unbleached kraft paperboard manufactured for use as facing material when combining paperboard for conversion into corrugated or solid fiber boxes. Includes solid unbleached kraft linerboard, both Fourdrinier and Cylinder, mottled white linerboard and clay coated unbleached kraft linerboard.

Corrugating Medium. Unbleached kraft paperboard manufactured for use as the fluting material when combining paperboard for conversion into corrugated boxes.

Folding. Paperboard manufactured, such as clay coated unbleached kraft and bleached lined unbleached kraft backed, for conversion into folding cartons and beverage carriers.

Other. All unbleached kraft paperboard whose end use is not otherwise classified, such as board for a filler for solid fiber board to be fabricated into a shipping container, tube, can, drum, file folder tag, automotive panel, etc.

Solid Bleached Packaging Paperboard. Paperboard made for use in packaging from a furnish containing not less than 80% virgin bleached chemical wood pulp. (Bleached bristols not manufactured for packaging are included in the proper bleached Bristol classification under paper).

Linerboard. Solid bleached paperboard, either Fourdrinier or Cylinder, manufactured for use as facing material when combining paperboard for conversion into corrugated or solid fiber boxes.

Folding. Solid bleached paperboard for conversion into folding cartons, such as folding cartons for ice cream, butter, oleomargarine, frozen foods, bakery products, cosmetics, drugs, etc.

Milk Carton and Food Service. Solid bleached paperboard for conversion into milk carton, heavyweight cup, and round nested food container, plate, dish and tray, and for packaging for moist, liquid and oily foods.

Other. Solid bleached paperboard for conversion into packaging of blister pack, tubes and other products not classified above and for industrial products not classified under bleached bristols.

Semi-Chemical Paperboard. Paperboard made from a furnish containing not less than 75% virgin wood pulp, the predominant portion of which is produced by a semi-chemical process.

RECYCLED:

Recycled Paperboard. Paperboard manufactured from a combination of recycled fibers from various grades of paper stock with the predominant portion of its furnish being recycled fibers--sometimes including a very minor portion of virgin fibers.

Linerboard: Recycled paperboard produced from a furnish containing less than 80% virgin kraft wood pulp and used as facing material when combining paperboard for conversion into corrugated or solid fiber boxes.

Corrugating Medium. Recycled paperboard produced from a furnish containing less than 75% virgin wood pulp and used as the fluting material when combining paperboard for conversion into corrugated boxes.

Container Chip and Filler Board. Recycled paperboard manufactured as a filler for solid fiber board for conversion into solid fiber boxes and other container chipboard (all chipboard under 26# per m sq. ft. manufactured for use as facing corrugated, solid fiber and single faced products which are used for interior packing, e.g., pads, partitions, dividers, layers and cushioning).

Folding. Recycled paperboard manufactured with bending quality for conversion into folding cartons (including unlined chipboard, kraft lined, white lined and clay coated).

Set-Up. Recycled paperboard manufactured with non-bending specifications for conversion into rigid or set-up boxes (including plain chipboard, newslined, white vat lined).

Gypsum Wallboard Facing. Recycled paperboard manufactured for use as liner or facing on gypsum board, plasterboard (includes white, cream, gray, blue and all colors).

Other. Recycled paperboard with the same characteristics as paperboard for bending packaging or non-bending packaging but for non-packaging uses; plus recycled paperboard for end uses not otherwise classified, such as tag, file folder, tube, can, drum, match stem, tablet backs, toys, etc.

Paper Stock. Waste paper which has been processed to a form suitable for use in a papermaking process. Paper stock and waste paper are terms commonly used interchangeably.

Pareto Optimality. A condition of economic efficiency under which it is impossible to better one societal unit's condition without worsening another's, via reallocation.

Paybacks. Number of years necessary for cash flow to return plant and equipment investment, measured from end of last year before first operation.

Point. (1) One thousandth of an inch. It is used in expressing the thickness of paper or board. (2) A term used for expressing certain values of paper properties--e.g., points per pound, pounds per point. (3) The printer also uses the point as a unit of measurement; it is practically one seventy-second of an inch (actually it is 0.013837 of an inch).

Post Consumer Waste. Any product that has gone through its useful life, served the purpose for which it was intended, and been discarded by the user. Waste or scrap created in a manufacturing or converting operation is not considered post-consumer waste. However, post-consumer waste is generated in homes, commercial establishments, industrial plants, institutions, government offices and the like.

Pro-Forma. Before the fact, expected, projected.

Prompt Waste. Waste generated in the manufacturing process itself (not from an end use). see Broke (q.v.)

Pulping. The operation of reducing a cellulosic raw material, such as pulpwood, rags, straw, reclaimed paper, etc., into a pulp suitable for further processing into paper or paperboard or for chemical conversion (into rayon, cellophane, etc.).

Recycling. An activity whereby a secondary material is introduced as a raw material into an industrial process in which it is transformed into a new product in such a manner that its original product identity is lost.

Recycling Rate. In this report used to mean percentage of total fibrous input that is waste paper. Midwest Research Institute uses secondary input ÷ total consumption of output grade.

Refiner. A machine used to rub, macerate, bruise, and cut fibrous material, usually cellulose, in water suspension to convert the raw fiber into a form suitable for formation into a web of desired characteristics on a paper machine. The many types of refiners differ in size and design features but most can be classified

as either jordans or disk refiners. Beaters are not usually referred to as refiners although in a broad sense they serve a similar function. Refiners may be used in various combinations of types and numbers of units depending on the type of stock to be treated and the capacity required.

Resin. A general term applied to various amorphous solid or semisolid organic substances insoluble in water but soluble in organic solvents, and classified as natural or synthetic.

Return on Investment (ROI). A relative measure of project desirability. ROI is a loosely used term which may include internal rate of return (q.v.) and return on net assets (q.v.).

Return on Net Assets (RONA). Return measure often used in the paper industry. This report used a 5 year RONA calculated as follows:

$$\frac{\text{Cash flow in operating years 1, 2, 3, 4, 5}}{5}$$

$$\frac{\text{Plant + Equip.} - \frac{5}{2} \left[\frac{\text{Plant Invest.}}{\text{Plant Life}} + \frac{\text{Equipment Invest.}}{\text{Equip. Life}} \right]}{\text{+ Working Cap.}}$$

Secondary Stock. Fibers which have been previously used in the papermaking process. The term includes paper stock reclaimed from waste papers as well as set or dry broke.

Sizing. (1) Relates to a property of paper resulting from an alteration of fiber surface characteristics. In terms of internal sizing it is a measure of the resistance to the penetration of water and various liquids. In terms of surface sizing it relates to the increase of such properties as water resistance, abrasion resistance, abrasiveness, creasability, finish, smoothness, surface bonding strength, and printability, and the decrease of porosity and surface fuzz. (2) The addition of materials to a papermaking furnish or the application of materials to the surface of paper and board to provide resistance to liquid penetration and, in the case of surface sizing, to affect one or more of the properties listed in (1).

Social Context. Any generalizable corporate or industry attitudes or norms.

Softwood. The softwoods, otherwise known as coniferous woods, come from coniferous trees such as the pines, spruces, and hemlocks. The leaves are needlelike, linear, awl-shaped, or scale-like, and the seeds are borne either in cones in the axil of a scale, or naked. Softwoods are also designated as nonporous woods.

Stability. The ability of paper or paperboard to resist change in any of its properties on exposure to various conditions.

Standard Brightness. A standard adopted by the paper industry originally for grade differentiation and specification and currently for specification and control. It is expressed as reflectivity for blue light when measured on instruments employing C.I.E. geometry with specified spectral, geometric, and photometric characteristics. It is sometimes called G.E. Brightness after the manufacturer who made the original instruments.

Stock. (1) Pulp which has been beaten and refined, treated with sizing, color, filler, etc., and which after dilution is ready to be formed into a sheet of paper. (2) Wet pulp of any type at any stage in the manufacturing process. (3) Paper on inventory or in storage. (4) Paper or other material to be printed, especially the paper for a particular piece of work. (5) A term used to describe a paper suitable for the indicated use, such as coating raw stock, milk-carton stock, tag stock, towel stock, etc.

Strategic Context. Herein refers to the strategic business plan.

Structural Context. The organizational and control mechanisms which overlay and shape corporate processes.

Tear Factor. The tearing resistance (q.v.) in grams (per sheet) multiplied by 100 and divided by the basis weight in grams per square meter.

Tearing Resistance. The force required to tear a specimen under standardized conditions. There are three terms in common usage: (1) Internal (or continuing) tearing resistance, wherein the edge of the specimen is cut

prior to the actual tear. The value is commonly expressed in grams of force required to tear a single sheet. (2) Edge tearing resistance. (3) Torsion tearing resistance of paper or paperboard is the energy expended in propagating a tear when the tearing force is applied in such a manner as to create a twist or torque.

Tensile Strength. The force, parallel with the plane of the paper, required to produce failure in a specimen of specified width and length under specified conditions of loading. This definition must be distinguished from that which is commonly used in engineering practice which expresses the tensile strength in force per unit area. In the paper industry, it is expressed as load per unit width, or as Breaking length.

Test Board. A container board which meets the requirements set forth in Rule 41 of the Consolidated Freight Classification.

Viscosity. (1) The property of a fluid which is exhibited in resistance to deformation or flow and in which the viscous stresses brought into play are related to the rate of deformation. If the viscous stress is proportional to the rate of deformation, the fluid is said to exhibit Newtonian behavior. (2) The property of a cellulose pulp or other polymer which is expressed by the viscosity of a solution of the material in a suitable solvent under specified conditions. The viscosity is related to the strength and other properties of the fibers.

Wet Machine. A machine used to form pulp into thick rough sheets sufficiently dry to permit handling and folding into bundles (laps) convenient for storage or transportation. It consists essentially of a wire-covered cylinder which rotates in a vat containing the stock and collects the pulp on its surface from which the pulp is removed by a couch roll and a felt. The wet web is allowed to wind around the upper press roll until the pulp or board reaches the desired thickness, when it is stripped off the roll in the form of a thick sheet. The wet machine is also used to manufacture certain types of boards which are dried and finished; among these are binders, book, coaster, counter, dobby, electrical pressboard, filter, friction, fuller, genuine pressboard, heeling, inner-sole, leather, matrix, middlesole, panel, shank, shoe, and trunk fibreboard.

WOOD PULP

Dissolving & Special Alpha. Highly refined bleached white sulphite or sulphate pulps with a high content of alpha (pure cellulose fiber).

Sulphite Paper Grades. Paper grade pulps produced by the sulphite process. Bleached pulp must achieve a G.E. Brightness of more than 75.

Sulphate & Soda Paper Grades. Paper grade pulps produced by the sulphate (Kraft) or soda process. Bleached pulp must achieve a G.E. Brightness of more than 75. Semi-bleached pulp must achieve a G.E. Brightness of not less than 45 or more than 75.

Semi-Chemical. High yield pulps produced with the use of some chemical agent such as neutral sulphite, alkaline cook, chemipulp, etc.

Groundwood. Relatively short-fibered pulps produced by mechanically grinding wood rather than by reducing it to fiber by chemical action.

Defibrated/Exploded. Defibrated - Pulp produced mechanically by means of a Defibrator. Used principally in the manufacture of hardboards, insulating boards and roofing felts. Exploded - Pulp produced by subjecting wood chips to very high steam pressure. Used primarily in the production of hardboards.

Screenings. Rejects and off-quality screenings from all grades of wood pulp except dissolving.

APPENDIX I: OVERVIEW OF SIC CODES
AND DESCRIPTIONS FOR
PAPER AND RELATED PRODUCTS

Major Group 08.--FORESTRY
The Major Group as a Whole

This major group includes establishments primarily engaged in the operation of timber tracts, tree farms, forest nurseries, and related activities such as reforestation services and the gathering of gums, barks, balsam needles, maples sap, Spanish moss, and other forest products.

Group No.	Industry No.	
081		TIMBER TRACTS
	0811	Establishments primarily engaged in the operation of timber tracts or tree farms for the purpose of selling standing timber. Establishments holding timber tracts as real property (not for sale of timber) are classified in Industry 6519; and logging camps and logging contractors in Industry 2411.
082		FOREST NURSERIES AND TREE SEED GATHERING AND EXTRACTING
	0821	Forest Nurseries and Tree Seed Gathering and Extracting Establishments primarily engaged in growing trees for purposes of reforestation and gathering, extracting, and selling tree seeds.
084		GATHERING OF MISCELLANEOUS FOREST PRODUCTS, EXCEPT TREE SEEDS
	0843	Extraction of Pine Gum Establishments primarily engaged in the extraction of pine gum. The concentration or distillation of pine gum, when carried on in the forest, is included in this industry.
	0849	Gathering of Forest Products, Not Elsewhere Classified Establishments primarily engaged in gathering forest products, not elsewhere classified. The concentration or distillation of these products, when carried on in the forest, is included; the extraction of pine gum is classified in Industry 0843.
085		FORESTRY SERVICES
	0851	Forestry Services Establishments primarily engaged in performing, on a contract or fee basis, services related to timber production, wood technology, forestry economics and marketing, and other forestry services, not elsewhere classified, such as cruising timber, firefighting, and reforestation.

STANDARD INDUSTRIAL CLASSIFICATION

Major Group 26.--PAPER AND ALLIED PRODUCTS

The Major Group as a Whole

This major group includes the manufacture of pulps from wood and other cellulose fibers, and from rags; the manufacture of paper and paperboard; and the manufacture of paper and paperboard into converted products such as paper coated off the paper machine, paper bags, paper boxes, and envelopes. Certain types of converted paper products are classified elsewhere, such as abrasive paper in Industry 3291, carbon paper in Industry 3955, and photosensitized and blueprint paper in Industry 3861.

Group Industry

No. No.

261 PULP MILLS

2611 Pulp Mills

Establishments primarily engaged in manufacturing pulp from wood or from other materials such as rags, linters, waste paper, and straw. Logging camps operated by pulp mills, and not separately reported, are also included in this industry. Establishments primarily engaged in cutting pulpwood are classified in Industry 2411; and pulp mills combined with paper mills or paperboard mills, and not separately reported, are classified with the latter in Industries 2621 and 2631, respectively.

262 PAPER MILLS, EXCEPT BUILDING PAPER MILLS

2621 Paper Mills, Except Building Paper Mills

Establishments primarily engaged in manufacturing paper (except building paper--Industry 2661) from wood pulp and other fibers, and which may also manufacture converted paper products. Pulp mills combined with paper mills, and not separately reported, are also included in this industry; where separately reported, they are classified in Industry 2611. Establishments primarily engaged in manufacturing converted paper products from purchased paper stock are classified in Groups 264 or 265.

Group No.	Industry No.	
263		PAPERBOARD MILLS
	2631	Paperboard Mills
		Establishments primarily engaged in manufacturing paperboard, including paperboard coated on the paperboard machine, from wood pulp and other fibers; and which may also manufacture converted paperboard products. Pulp mills combined with paperboard mills, and not separately reported, are also included in this industry; where separately reported they are classified in Industry 2611. Establishments primarily engaged in manufacturing converted paperboard products from purchased paperboard are classified in Groups 264 and 265, and building board in Industry 2661.
264		CONVERTED PAPER AND PAPERBOARD PRODUCTS, EXCEPT CONTAINERS AND BOXES
	2641	Paper Coating and Glazing
		Establishments primarily engaged in manufacturing coated, glazed, or varnished paper from purchased paper. Also included are establishments primarily manufacturing pressure sensitive tape with backing of any material other than rubber. Establishments primarily engaged in manufacturing carbon paper are classified in Industry 3955 and photographic and blueprint paper in Industry 3861.
	2642	Envelopes
		Establishments primarily engaged in manufacturing envelopes of any description from purchased paper and paperboard. Establishments primarily engaged in manufacturing papeteries (boxed stationery) are classified in Industry 2642.
	2643	Bags, Except Textile Bags
		Establishments primarily engaged in manufacturing bags from purchased paper, cellophane, acetate, polyethylene, polypropylene, pliofilm, foll, and similar sheet or film materials.

- 2645 Die-Cut Paper and Paperboard and Cardboard
Establishments primarily engaged in diecutting purchased paper and paperboard; and in manufacturing cardboard by laminating, lining, or surface coating paperboard. Establishments primarily engaged in laminating building paper or building board from purchased paper or board are classified in Industry 2649.
- 2646 Pressed and Molded Pulp Goods
Establishments primarily engaged in manufacturing all kinds of pressed and molded pulp goods, including papier-mache articles other than statuary and art goods (Industry 3299). Establishments primarily engaged in manufacturing plates and utensils from paper are classified in Industry 2654.
- 2647 Sanitary Paper Products
Establishments primarily engaged in manufacturing, from purchased paper, sanitary paper products, such as facial tissues and handkerchiefs, table napkins, toilet paper, towels, disposable diapers, and sanitary napkins and tampons.
- 2648 Stationery, Tablets and Related Products
Establishments primarily engaged in manufacturing stationery, tablets, looseleaf fillers, and related items from purchased paper. Establishments primarily engaged in manufacturing envelopes are classified in Industry 2642.

2649 Converted Paper and Paperboard Products, Not Elsewhere Classified

Establishments primarily engaged in manufacturing from purchased paper or paperboard miscellaneous converted paper or paperboard products, not elsewhere classified. Establishments primarily engaged in manufacturing sanitary paper products from purchased paper are classified in Industry 2647. The paper stock used for wallpaper called "hanging paper" is classified in Industry 2621. Establishments primarily engaged in manufacturing stationery, tablets and related products are classified in Industry 2648.

265 PAPERBOARD CONTAINERS AND BOXES

2651 Folding Paperboard Boxes

Establishments primarily engaged in manufacturing folding paperboard boxes from purchased paperboard.

2652 Set-up Paperboard Boxes

Establishments primarily engaged in manufacturing set-up paperboard boxes from purchased paperboard.

2653 Corrugated and Solid Fiber Boxes

Establishments primarily engaged in manufacturing corrugated and solid fiber boxes and related products from purchased paperboard of fiber stock. Important products of this industry include corrugated and solid fiberboard boxes, pads, partitions, display items, pallets, single face products, and corrugated sheets.

2654 Sanitary Food Containers

Establishments primarily engaged in manufacturing food containers from special food board. Important products of this industry include fluid milk containers; folding paraffined cartons for butter, margarine, and shortening; ice cream containers; frozen food containers; liquid tight containers; round nested food containers; paper cups for hot or cold drinks; pails for food and ice cream; and stamped plates, dishes, spoons and similar products. Establishments primarily engaged in manufacturing similar items of plastics materials are classified in Industry 3079.

2655 Fiber Cans, Tubes, Drums, and Similar Products

Establishments primarily engaged in manufacturing from purchased materials fiber cans, cones, drums, and similar products with or without metal ends, and vulcanized fiber boxes.

Group No.	Industry No.
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266	BUILDING PAPER AND BUILDING BOARD MILLS
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2661	Building Paper and Building Board Mills
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Establishments primarily engaged in manufacturing building paper and building board from wood pulp and other fibrous materials. Pulp mills combined with building paper and building board mills, and not separately reported, are also included in this industry: where separately reported, they are classified in Industry 2611.

APPENDIX II. GENERIC DISCUSSION OF SUBSIDY
TYPES AND EVALUATION OF SPECIFIC PROGRAMS

Section

Introductory Table: Types of Subsidies

1. CASH
2. TAX
3. CREDIT
4. BENEFIT-IN-KIND
5. PURCHASE
6. REGULATORY

Appendix Table II.1. TYPES OF SUBSIDIES ^a

Form of Subsidy	Capital	Operating
Cash	1. Revenue Sharing -- Non Categorical 2. Construction Grant 3. Equipment Grant Second and third based on: A. Total Costs B. Differential Costs Second and third could be in form of cash interest (credit) subsidy. 4. Research in Capital Production Methods	2. Operating Grants based on: A. Operating Income B. Input i. Physical Units ii. Costs a. Total b. Partial c. Differential C. Output i. Physical Units ii. Revenue a. Total b. Partial D. Market Demand 3. Research in Operating Methods
Tax	1. Inv. Tax Credit 2. Accelerated Depr. 3. Capital Gains 4. Percentage Depletion 5. Ability to Raise Credit at Tax Free Rates	1. Deferral of Taxes 2. Depletion Allowance 3. Tax credit based on: A. Operating Income B. Input i. Physical ii. Costs a. Total b. Partial c. Differential C. Output i. Physical ii. Revenue a. Total b. Partial D. Market Demand

TYPES OF SUBSIDIES (CONTINUED)

Form of Subsidy	Capital	Operating
Benefit-in-Kind	1. Government provides capital equipment at less than cost 2. Government provides information: i. Research and development results ii. Choice of production process--choice of capital equipment	1. Government provides materials at less than cost 2. Government provides information: i. On market characteristics and their implications (planning) ii. On best methods of operation (supply--delivery) iii. To encourage demand and/or supply iv. To change attitudes v. Data banks 3. Stabilize prices or provide liquidity or hedging ability 4. Other services - like where user charges do not cover costs
Credit	1. Direct government loan at favorable rate 2. Government guarantees interest and/or principal 3. Government insures lender 4. Government lends to creditors who could not otherwise borrow	May be viewed sometimes as operating sub.
Purchase	1. Government sets content requirements for purchases which alter capital goods mix.	1. Government buys output at more than market rate. 2. Government sets content requirements for purchases.
Regulatory	1. Regulation based on ROI 2. Regulation based on product characteristics which alter capital goods mix	1. May also be viewed as an operating subsidy 2. Regulation based on market measures 3. Regulation based on product characteristics

^aSource: Resource Planning Institute.

Cash Subsidies

Cash grants may be non-categorical as in revenue sharing, or they may be used to subsidize specific aspects of capital and/or operating expenditures. Cash capital subsidies may take the form of construction grants, equipment grants, cash interest payments, or payments for research into capital production methods. Cash operating grants are cash payments based on any one or a combination of performance measures, or they may consist of payments for research into better operating methods.

Cash Capital Subsidies

Cash capital subsidies, principally construction and equipment grants, are often characterized by the features indicated in Table II.2. Several examples will best serve to illustrate the implications of these characteristics.

Waste Water Treatment Plants

The construction grant program for waste water treatment plants is a subsidy based on total cost. It is open to the same criticism any capital subsidy is: that it encourages capital intensive solutions which may be less than optimally efficient. The General Accounting Office issued an evaluative report on the waste water construction grant program. The GAO concluded that the program had been administered using a "shotgun" approach, grants being awarded on a first come first served or a readiness-to-proceed basis with little consideration being given to the immediate benefits from the construction of individual treatment plants. Further, federal funding had not been adequate to meet the demands, resulting in the delay of many construction projects; municipalities did not want to start their project until they had received a grant. Apart from more adequate funding, the GAO report made specific recommendations for improvements to the program, recommending that:

- a. A coordinated priority system for the awarding of grants be based on the projected benefits from those grants, and not the financial need of the recipient.
- b. The Federal Water Pollution Control Administration consider utilizing systems analysis for planning and implementing pollution

Appendix Table II.2. CHARACTERISTICS OF CASH
CAPITAL SUBSIDY USE ^a

-
-
- . Used Where Capital Poverty is Perceived as Problem
 - . Generally High Administrative Cost
 - . High Visibility
 - . Limit Federal Government Liability
 - . Prevalent Belief that They Restrict Power of Unions
 - . Encourage: Overcapitalized Technology
Inadequate Maintenance
Premature Replacement
 - . High Net Budgetary Cost
 - . Straightforward and Understandable
 - . Very Controllable
 - . Generally Low Involvement of Federal Government in
Local Decisions
 - . Congressional Committee Overview
 - . Little Time Frame Problem
-

^aSource: Resource Planning Institute.

control. Data could be provided to the states which could assist in:

- i. Determining the water pollution control requirements.
- ii. Identifying alternatives available.
- iii. Formulating plans.
- iv. Establishing schedules and priorities.

Urban Mass Transportation

The Department of Urban Transportation has used cash capital subsidies, considered cash operating subsidies, and settled on non-categorical revenue sharing. Its experience should prove instructive.

The goals of the transportation subsidy¹ have many similarities with those of a subsidy for resource recovery, including:

- . To redress the effects of preferences and technical progress in competing modes.
- . To encourage adaptation, innovation, and experimentation with new forms of production.
- . To produce coordinated policy.
- . To insure consideration of the subsidized area as a positive force in implementing growth and development objectives.

The arguments for restricting mass transportation aid to capital grants were the following:²

- . Capital Poverty. The consultants for the project³ believed that a great source of inefficiency in mass transportation was undercapitalization. The cause for this opinion might be described as the "nincompoop thesis."⁴ That thesis stated that urban personnel failed to perceive the trade-offs between capital and operating expenditures in a way which would maximize transportation efficiency. They believed that

any "aid for service"⁵ would be dissipated by wasteful management. The evidence presented to support this position was the apparent undercapitalization of transportation facilities.

In fact, transportation was not undercapitalized (just using older equipment to lower total costs), and officials making transportation decisions were responding as might be expected to the mix of pressures upon them, including subsidies for highway construction and voter preferences.

- Restriction of union power to dissipate subsidy gain in wages. The incidence of a subsidy falling upon wage rates would result only if the supply of necessary labor were very inelastic. The restriction of the subsidy to a categorical capital grant would be unlikely to affect the incidence of the subsidy because such inelasticity pressure is well transmitted through most systems, as in the case of urban mass transit.
- Limit the federal government's liability. Capital grants do indeed limit the liability of the federal government relative to cash operating subsidies or tax subsidies. With a cash capital grant, subsidy expenditure may be controlled in advance by limitations upon total funding written into law or understood by the administering agency. Capital grants are considerably easier to terminate than operating subsidies, since the termination of an operating subsidy may cause those invested with expectation of a continuing subsidy to incur heavy termination cost. The ability to terminate a program which may prove misdirected, thus pointing toward a cash capital grant subsidy, is clearly of greatest significance at the point of program inception.

The results of the capital grant program in attempting to end the vicious cycle of increased fares and reduced riderships in urban mass transportation systems were very discouraging. The restriction of subsidies to capital grants encouraged wasteful, premature replacement, overcapitalized technology, and inadequate maintenance.⁶

The replacement decision for a capital asset involves minimizing the long-run total cost of operating expenses plus depreciation and interest. A decrease in the cost of a replacement asset reduces optimal equipment lifetime, other

things being equal. Dr. Tye found that in Cleveland and Chicago, optimal bus lifetime was halved by the two-thirds federal capital subsidy. Thus, costs exceeded benefits, with more than 22 percent of the federal grant not being recovered in lower long run average costs. Further, since the law excluded from the capital subsidy any portion of capital costs covered by operating revenues, when receipts exceeded operating expenditures, the result was that the federal government paid a large part of any increase in expenses, which encourages featherbedding and other operating inefficiencies.

The failure of the capital subsidy to end the urban transportation vicious cycle, combined with continued pressure from local political forces for an operating subsidy caused the Department of Transportation to examine in detail the feasibility of an operating subsidy for urban mass transportation.

Cash Operating Subsidies

Cash operating subsidies may be based on any of the parameters listed in Appendix Table II.1: operating income, input parameters, output parameters, or market demand. Operating subsidies tend to have the characteristics outlined in Appendix Table II.3.

Cash Operating Subsidies in General

Characteristics include:

- . Complicated Administration. Cash subsidies have, in the past, involved tighter administrative controls on expenditures than most other forms. Because operations tend to involve more on-going details than capital choices, administration has been more complex. In fact, for any subsidy to be effective, the administering agency needs to be concerned with the details of operation of subsidized factors.
- . Often Generates Concern Over Federal Involvement in Local Decisions. Because operating subsidies have typically involved the specification of some of the operating details, subsidized factors have raised the issue of too much federal control over local issues.

Appendix Table II.3. CHARACTERISTICS OF CASH
OPERATING SUBSIDY USE^a

- . Complicated Administration
- . Often Generates Concern Over Federal Involvement in
Local Decisions
- . Relatively High Net Budgetary Cost
- . Difficult to Control
- . Broadest Applicability
- . Congressional Committee Overview
- . Time Frame Concern

^aSource: Resource Planning Institute.

This is a false issue to the extent that for effectiveness most subsidies require the specification of numerous operating details by the subsidizer.

- . Relatively High Net Budgetary Cost. Any cash subsidy appears in the budget in full.
- . Difficult to Control. Operating subsidies tend not to have their levels determined in advance; they depend on deficits, revenues, production, or market price - factors not under the federal government's control. Further, operating subsidies often build strong constituencies which make change or repeal difficult.
- . Broadest Applicability. Such subsidies may be used in any situation, regardless of tax or capital position.
- . Congressional Committee Overview. Cash subsidies fall under the continuing scrutiny of knowledgeable House and Senate committees.
- . Time Frame Concern. Because cash operating subsidies are highly visible, actors may be reluctant to make commitments into the future based on continuing receipt of a subsidy, fearing repeal or adjustment in level.

Cash Operating Subsidies to Operating Income

A cash subsidy based on operating income amounts to financing the deficit. While such a strategy may have low administrative costs (because the federal government does not become involved enough to insure efficient operations), it does not encourage efficiency or innovation by financing the status quo. This is accentuated by the provision of funds for only unprofitable operations. Further, deficit financing encourages uneconomically low user charges, from a Pareto optimality viewpoint.

Cash Operating Subsidy to Input Parameters

Characteristics include:

- . Encourages Inefficient Use of Subsidized Input.
Any input subsidy encourages operating inefficiency through overutilization of subsidized inputs. While this may serve to consume the supply of the subsidized factor (desirable), it discourages the innovation, experimentation, and efficiency which would mark the viability of a long-run unsubsidized market. Such inefficiency is illustrated by the subsidization of the operating differential between costs of United States registered ships and foreign registered ships. The result has been a very difficult subsidy to control, with numerous charges of wage passthrough and lack of efficiency incentive. The maritime unions have succeeded in receiving such favorable contracts that regulatory (cabotage) subsidies have been required, indicating that only subsidized United States registered vessels may engage in domestic commerce. Maritime operating cash subsidies are granted under 20-year contracts, thus eliminating one of the major problems with cash subsidies; that is, that they may not be regarded as permanent.
- . Unpredictable Results. Since many output configurations are possible with the same inputs, there is no assurance that the subsidy will help to achieve more fundamental objectives.
- . Provides Incentive to Market Innovation.
Because the subsidy is to input parameters, there is an incentive to market effectively and design products which appeal to the market (since for an individual firm, the subsidy will not be reduced with an increase in revenues).

Cash Operating Subsidy to Output Parameters

Cash operating subsidies may be based on the output parameters of physical units or revenue. Characteristics include:

- . Require Specification of Output. Whether based on physical units or revenue, such subsidies require specification of the form of output. If not, goods or services may be provided for which there is inadequate demand, as in the case of compost.
- . Promotes Cost Efficiency. This is the obverse of an input subsidy; here cost efficiency is encouraged since output is subsidized.
- . Encourage Uneconomically Low User Charges. This is true where revenue, not physical unit output, is subsidized.

Market Subsidy

A market subsidy is an operating subsidy based upon the difference between the current market price (area or nation-wide, depending on the results of further cost/effectiveness analysis) for the category of subsidized material a processor has sold and an agency determined index price based on cost/output calculations. The level of dollar payment is not based upon the selling price received by a particular processor but on an average market price. The characteristics of the PCW market subsidy include:

- . Encourage Efficiency and Innovation. Because the subsidy is based on the market price for the product, rather than manufacturing variables, there is every incentive to produce as efficiently as possible.
- . Encourages Proper Marketing and Design. Because the subsidy does not vary with revenue from an individual subsidized processor, each actor is required to effectively market in order to receive the average market price. If he receives more than the average market price, his subsidy is not reduced.

Cash Capital vs. Cash Operating Subsidies

Any categorical federal subsidy requires the assumption of agreement on national priorities which interface with the execution of local preferences, whether those national priorities are for the construction of capital equipment or for the subsidization of particular operating characteristics. The specification of service characteristics under operating grants has tended to be greater in the past than under capital grants, perhaps because capital grants were considered to be solutions to a more obvious capital need problem than to the complicated multi-dimensional problem operating grants were often understood to face. For this reason, capital grants have been favored by those who dislike intensive federal intervention in local matters. For instance, the National League of Cities and the U.S. Mayors Conference indicate that no federal program should "dictate standards for levels of service,"⁷ i.e., planning assistance should be retained in the capital grant, not operating grant, phase of any urban transportation program.

In general, there is no asymmetry between capital grants and operating grants. Capital grants encourage capital waste and inefficiency while operating grants encourage operational waste and inefficiency. Subsidy programs such as highways, public housing, foreign aid, and education which measure success in terms of output of capital goods created, rather than the long-run production from those capital goods created, result in misallocations from the incentive to reduce operating cost to inefficiently low levels.⁸

Revenue Sharing

Revenue sharing has been viewed by many as the solution to the problem of categorical inefficiencies versus over-involvement by the Federal government in local affairs. The characteristics of revenue sharing include:

- . Local users of funds make capital versus operating expenditures decisions. This may or may not increase economic efficiency, depending on ability of users to make proper choices. It would increase matching of expenditures with user preferences where the local decision-making process is geared to user, not politician's preferences.

- . Revenue sharing reduces the tendency for recipients to regard funds as "free money." Some cash grant programs, like Model Cities, inspired recipients to be sure and get "their share" of a special Federal program, whether the funds were used accordingly or not. The New York City garbage truck example is appropriate. Model Cities bought NYC new garbage trucks to increase the frequency and appearance of collections in certain ghetto sections in an effort to generally uplift the area. Once the garbage trucks got into the DPW bureaucracy, however, they were misallocated to other areas and used as replacements for broken trucks, subverting the intent of the subsidy program. Presumably, revenue sharing funds, based more on a formula plan, which may be anticipated by users, will better integrate the funds into planning in line with subsidy goals.
- . Revenue sharing is very popular with the Nixon administration.

The Transportation Department has recently suggested revenue sharing for the solution to the urban mass transportation problem. This is a response to the failure of the capital grant program, the political problems with Federal dictation of operating details which appear inherent in an operating subsidy (which has been requested by many localities), and pressure from the Nixon Administration to include as many programs in revenue sharing as possible. Mr. Casper Weinberger, recently promoted to head the Office of Management and Budget, suggested making urban mass transit subsidies part of a general Transportation Revenue Sharing system. To the extent, however, that lack of funds are not the real problem in urban mass transit, such a subsidy will not significantly change the situation. If the problems are low income elasticity of demand and decentralization of homes and workplaces, then a different subsidy type and place of application appear in order.

Research in Capital and Operating Methods

This capital subsidy is perhaps the most straightforward and appealing from an economic standpoint. A federal subsidy to research, either to capital production methods

or operating technology, may be directed precisely to those pressure points which are causing supply or demand inelasticity and thus which would severely limit the effectiveness of any other subsidy program alone. The Department of Agriculture has been providing such subsidies successfully for years. Research subsidies are certainly one of the Agriculture Department's least controversial programs. As with any other subsidy, the application of research subsidies requires careful analysis of factors which create problems in supply and demand in order that federal funds may be most efficiently applied.

Tax Subsidies

Tax incentives may generally be translated without difficulty into equivalent cash subsidies. The choice of a tax subsidy is a political decision, revolving principally about the fact that in the past tax subsidies were passed by Congress with much less careful scrutiny than cash subsidies, perhaps because their indirect expenditure did not appear in the federal budget. Because of past ease of passage, many tax subsidies received little careful justification before passage and upon examination appear to be political programs whose economic justification is very weak.

When applied to profit-making entities, the economic characteristics of tax and cash subsidies are similar. Thus, this discussion will center around the pros and cons of tax versus cash subsidies.

Supposed Advantages of Tax Incentives vs. Cash Grants

- . Encouragement of private sector to participate in subsidized programs. Daniel Holland¹⁰ shows that surveys of businessmen indicate no preference for tax vs. cash subsidies in the JOBS programs. It would seem a priori, then, that cash subsidies are easier to understand and with the elimination of legislative or continuance worries would be preferable to tax subsidies, providing administrative policies were similar.
- . Tax incentives are simpler and cheaper for the U.S. government--that is they do not involve a bureaucracy with an agency. A tax subsidy with the same degree of effectiveness is not more

simply designed than a grant program which accomplished the same purpose. The fact that many tax subsidies have been enacted for political reasons and that cash subsidies were much more difficult to get through Congress in the past indicate why this view is held. That is, many tax subsidies presently on the books did not require the justification and red tape by applicants that cash subsidies do; thus, they control less of the variables that insure the subsidies' effectiveness, and are not equivalents. The tax subsidy for the timber industry, for instance, requires 25 IRS agents trained as timber specialists to administer the timber tax program.

- . From the requesting agency's point of view, tax subsidies appear to have been easy to get through Congress. In the past tax subsidies appear to have required less justification than cash or regulatory subsidies. Recently, the DISC subsidy appears to have passed Congress because it was not considered like cash. The current controversy over tax reform indicates the distinct possibility that this may not be true in the future. Examples of politically inspired tax subsidies to capital include capital gains, percentage depletion, deductibility of interest on home mortgages. Many of these tax subsidies to capital may in a way be regarded as subsidies to operations to the extent that they allow shifting of operating income to capital assets which are taxed at favorable rates, or subject to favorable tax exemptions.
- . From the agency's standpoint, tax subsidies may not receive annual Congressional review as would cash subsidies. This fact of the past may not be true in the future, and whether it is beneficial or harmful depends very much on the individual agency circumstance.
- . Tax subsidies have been perceived as long-term. Recent controversy over tax reform may be changing this attitude, as with DISC, where concern with duration was significant.

- . Tax subsidies have very low budgetary cost, their major component not being a budget item.

Disadvantages of Tax Vs. Cash Subsidies

- . Administratively less efficient. Tax programs are examined by the House Ways and Means and the Senate Finance Committee rather than by the committee nearest the area involved. This makes it difficult for Congress to properly manage national priorities. The House and Senate committees can be a real help to administering agencies, as in the case of HUD. Further, IRS agents enforce the subsidy. Because they are usually not geared to the purposes behind legislation, they are not as good auditors as would be the same personnel if working for the concerned agency.
- . Economic inefficiencies are caused by cost distortions. An excellent example of such inefficiencies is the federal tax subsidy of the timber industry.¹¹ The capital gains treatment for increases in the value of standing timber or for the leases of standing timber encourage virgin resource use and discourage use of recycled materials. The tax set-up encourages the conversion of ordinary income into capital gains by deducting expenses from regular income, but pushing profits back to that segment taxed at the capital gains rate. This encourages integration in the timber industry (90% of companies are integrated); that is, integrated firms charge as many expenses as possible to logging and manufacturing, rather than to timber development. This means that the transfer price of timber within an integrated company is high, with a low book profit in the areas not experiencing the capital gains. This subsidy amounts, however, to only .4 percent of the value at the bleach subsidy which discourages recycling being that municipalities provide disposal of waste material). But the cost distortion and induced integration do act against the entry into the market of post

consumer waste dealers who see the price of timber as a false price whose maintenance is dictated by the capital gains treatment and the integrated nature of the paper companies.

- . Inequitability and breadth of application. Tax subsidies by definition are worth more to high income taxpayers--they tend to be retrogressive. Usually they do not benefit or induce to action those outside of the tax system or at marginally low tax rates.
- . Tax subsidies often bring in extra parties. Subsidies which involve tax shelters may bring in two more parties than if returns to subsidized party did not involve tax bracket. That is, the tax shelter scheme may require a tax shelter broker and a high bracket investor in addition to the factor to be subsidized. Direct fees would avoid passive and absentee owners as well as syndication costs. These costs are certainly a net drain to the treasury.
- . Ease of evaluation. Cash subsidies are easier to identify, measure and control than tax, because of the "ex post" nature of tax incentives; that is, tax incentives leave many of the details up to users. In addition, the tax bracket determination of subsidy beneficiaries makes an understanding of net income transfer difficult.
- . Tax incentives tend not to be selective. In general, tax incentives do not define the subsidized product precisely enough. For instance, the investment tax credit is unable to distinguish between marginal investment and that which would be made anyway--giving rise to windfalls. A cash subsidy might not be offered at the same price to everyone; i.e., it would involve firm-by-firm bargains, for instance, matching needs by region or by supply and demand cycle characteristics. For the timber tax subsidy there are even significant problems defining "timber."

- . Tax may have less predictable results. As Mr. Holland points out,¹² as one moves down the hierarchy from corporate treasurer, the more direct the subsidy, the more understandable and predictable its effect. At the corporate decision level, tax or cash may be of equal understandability. But, if the decision-maker is, for instance, at the plant level, a tax credit is significantly less effective. A tax credit is reflected at the firm level, and a plant manager undertaking a direct differential loss for use of a subsidized product will be much less inclined to fulfill the intent of the subsidy than were a cash subsidy to be received.
- . Perceived complexity of tax subsidies. The smaller the firm, the less likely it is to engage in negotiations and paperwork necessary for a government subsidy. In the JOBS tax subsidy program less than 50 percent of eligible firms applied.¹³

Credit Subsidies

Credit subsidies may take the form of: direct government loans at favorable rates; government guarantees of interest and/or principal; government insurance of a lender; government loan to a creditor who could not otherwise borrow. Credit programs are perhaps the fastest growing of all federal subsidies, increasing from 13 billion dollars in fiscal year 1969 to 31 billion dollars in fiscal year 1972.¹⁴

The Department of Housing and Urban Development employs perhaps the widest range of credit subsidies. Its most successful, from a cost-benefit and effectiveness point of view, appear to be the mortgage guarantee programs. These programs are directed precisely at the problems in supply of funds to the subsidized market: high risk (and inability of lenders to charge a corresponding interest rate), and uniqueness of the risky instrument. The guarantee programs increase the attractiveness of particular mortgages to lenders by reducing the variance of return. Further, they increase

elasticity of demand for such mortgages (supply of funds for the mortgage market) by reducing the uniqueness of the mortgages, making them more like bonds, securities having numerous substitutes. Increased mortgage demand elasticity lowers the cost of any further credit subsidy for a given effectiveness.

Mortgage guarantees meet the specific needs of actors in the supply-demand cycle. They furnish the low variance of return for the subsidized mortgages which allows lenders to view them competitively with non-subsidized mortgages of lower perceived risk, and backed by circumstances more familiar and easily analyzable to the lender. But mortgage guarantees meet the interests of influential actors in yet another way. Politically influential lenders, such as savings and loan associations, are required by law to hold mortgages in their portfolio. Any action which makes these mortgages more like other securities will reduce the impact on the regulated institutions of such holding requirements. In addition, to the extent that rates on mortgages are kept within a low bound relative to other securities, mortgage guarantees represent a wind-fall to lending institutions who would otherwise hold subsidized mortgages.

The success of the mortgage guarantee program hinged on two major points:

- . It was aimed at the correct pressure point in supply and demand.
- . It met the needs of politically influential actors.

The multitude of HUD's other subsidies have not, however, been so successful. The agency is now enduring a scandal in its "235" housing program, where guaranteed mortgages were written for rehabilitated housing which was in fact not rehabilitated. Housing was sold to very low income people who almost immediately defaulted on loans, making the Federal Government liable to builders who inflated the cost of the "rehabilitated" housing. Perhaps this experience illustrates the fallacy in considering that credit or tax subsidies with similar intent entail less administrative cost than a cash subsidy. Housing "redevelopers" converted the credit subsidy almost directly to cash. Presumably, if the subsidy had been in cash far more administrative controls would have been involved. It is possible, though, that no reasonable amount of administrative control would

have prevented the "235" scandal; there already were numerous forms for housing rehabilitators to fill out in conjunction with HUD agents.

The general mix of HUD subsidies have not had the success mortgage guarantees have in pinpointing problem areas in supply or demand. This is the result of a problem in goal translation. The goal of most of the HUD programs was that the subsidized families be able to live in better surroundings. There were many more hindrances to the achievement of this goal than simply making supply more elastic. The provision of a credit subsidy to a municipality to erect and maintain a housing project, while insuring at least for some segments an elastic supply, did not insure an improvement in surroundings due to other factors in the environment. The market and the environment were too complicated for the nation's critical housing problems to be solved through even a large number of federally instigated specific projects. HUD is now working on a cash grant to purchasers of housing or purchasers of leases. Presumably such independent action, although possibly inflationary and at the start inefficient in terms of number of units, may result in psychic externalities which go a long way toward solving the problems of the subsidized groups and generate a long run efficient market for low and moderate income housing.

To the extent that the HUD subsidies, even cash subsidies to users, treat only a few of the areas which lead to a bad housing market for low and moderate income families, the subsidies will not be effective. This is not unlike the GAO's criticism of the capital grants for waste water treatment plants. That is, the goal of the capital grant program was the improvement of water quality. To the extent that plants were built at only a few offending locations on any particular river, the effectiveness of the subsidy was often negligible.

Export credit subsidies have been noticeably ineffective. The reason is straightforward: they are not aimed at the problem areas which cause inelastic demand for U.S. exports. The assumption behind export credit subsidies is that provision of credit is a major and necessary factor in promoting the demand for U.S. exports, and that this credit must be provided through the help of the U.S. government. In fact, credit is a relatively insignificant part of demand inelasticity, and most credit needs could be well met by the U.S. private capital markets. U.S. exports

continue to present a balance of payments problem due to the low income elasticity of demand for U.S. exports, combined with the higher income elasticity of demand for imports to the United States. This situation would imply a benefit-in-kind information subsidy which promoted abroad U.S. exports with high income elasticity of demand and within the United States an effort to induce manufacturers of such products to engage in export activities (to some extent the broad brush of DISC may accomplish a partial solution).

Benefit-in-Kind Subsidies

Benefit-in-kind subsidies are defined as the provision by the government of goods or services at less than cost. Goods may be operating or capital materials; services may be for the improvement of capital production methods or operating methods.

Benefit-in-kind capital equipment subsidies include government provision of capital equipment such as desks, etc., for Defense contractors. Government operating materials subsidies include sales to domestic ship scrappers at below market rates, or the provision of dumping facilities by municipalities for a stated tax rate charge which does not represent full cost for industrial users of such facilities.

The most desirable form of benefit-in-kind subsidies are information subsidies or service subsidies. Benefit-in-kind capital information subsidies include information on research and development results in the capital area, and assistance in the choice of production process and choice of capital equipment. Benefit-in-kind capital information subsidies have been recommended in the following instances:

- . The GAO recommended them for correction of defects in the water treatment capital equipment subsidy.
- . The Mayors Conference and the National League of Cities recommended them for the Urban Mass Transportation case.
- . HUD operates a strong information subsidy to increase knowledge of and use of its capital subsidies.
- . The Agriculture Department devotes substantial resources to research into capital production

methods and information about the choice of capital methods and equipment.

Government benefit-in-kind information subsidies on the operation side have similarly been used in a large number of instances:

- . They are used by HUD to change attitudes toward equity in housing and discrimination.
- . They are used by the Agriculture Department to encourage demand for U.S. exports overseas and to stimulate potential U.S. exporters.

Information subsidies on market characteristics and their implications for planning are perhaps the most important kinds of such subsidies. They have, however, rarely been applied. The GAO strongly recommended such subsidies in the case of waste water treatment plants.

Subsidies which either stabilize prices, provide liquidity, or offer the opportunity for the hedging of risks may be extremely valuable. The Federal National Mortgage Association and the Government National Mortgage Association provide benefit-in-kind subsidies to the extent that they reduce the illiquidity risk by making a secondary market in mortgages. To the extent that they make mortgages more like other securities, secondary markets raise the elasticity of demand for mortgages so supported. Where fluctuating demand causes inelasticity in supply, as in the mortgage credit market, or in a number of the markets for waste materials, the provision of liquidity services could do much to make demand elastic. Where direct liquidity provision as in GNMA and FNMA is not appropriate a benefit-in-kind subsidy designed to induce trading of the commodity involved might be very beneficial. Such trading would provide a valuable adjunct to planning services, which by nature are the hedging of risks, where understanding of all the factors involved may lead to lower risk perception.

Purchase Subsidies

A purchase subsidy is one in which the subsidizer purchases from the supplier the subsidized good at more than the market rate.

- . Purchases by the Defense Department are often examples of a purchase subsidy to capital goods.
- . The price supports of the Department of Agriculture are examples of purchase subsidies of an operating nature.

Characteristics of purchase subsidies include the following:

- . The effectiveness of a purchase subsidy depends upon the extent to which the purchases may change the shape or shift the demand curve. Defense Department originated purchases, where they represent the bulk of demand for subsidized goods, may be very effective. Agriculture price support subsidies similarly are effective in drastically changing the shape of the demand curve for the subsidized goods.
- . Administrative costs of purchase subsidies are high where possession of the purchased goods means an entry into the distribution system by the subsidizing agency. Thus administrative costs are least in the Department of Defense where it uses directly the purchased goods. Administrative costs would be more in the Department of Agriculture where it takes possession of subsidized goods for future use by other consumers. Administrative costs might be even larger where the agency desiring to do the subsidization would require actual purchases to be made by other government agencies, perhaps involving later sale to private parties.
- . Purchase subsidies may significantly alter dependence upon natural economic and social incentives. Marketing and product design efforts may be aimed toward the government purchaser rather than toward the private market--just compounding the problem. Once a purchase subsidy has been in effect, the entire market mechanism for that commodity is altered and the extent, cost, and fairness of administration of the subsidy become increasingly difficult to determine with coincident administrative problems.
- . The appearance of budgetary costs for purchase subsidies varies very much with the particular purchase subsidy. In the Agriculture Department

purchase subsidies appear as credit subsidies, with purchase resulting when loans are defaulted at the support price. In the Defense Department purchase subsidies are not separately accounted for, but are included with the total Defense bill.

- . Purchase subsidies often do not receive continued appraisal by Congress.
- . Because purchase subsidies are hidden from general view, or appear in disguised form, there is often little knowledge and thus opposition to them.

Regulatory Subsidies

Regulatory subsidies are used for three main purposes:¹⁵

1. Protect public from adverse effects of monopoly.
2. Used by members of regulated industry for their own benefit.
3. Allocative chores, like the tax system.

Protection of the public from adverse effects of monopoly is perhaps considered the normal use of regulation. In this case regulation is used to simulate the effects of the competitive market.

However, many firms in competitive markets seek regulation in order to use it for their own benefit (for example, the securities industry). For instance, the computer industry is a non-regulated industry and yet it probably has substantially less competition than either the securities industry, the trucking industry, or the airline industry. George Stigler¹⁶ notes that only when supply elasticity is small will the industry prefer cash to controls over entry or output (because it would have to share the cash subsidy with new entrants). Dr. Stigler offers the hypothesis that every industry or occupation that has enough power to utilize the state will seek to control entry by encouraging a regulatory policy that will retard the rate of growth of new firms. In a regulated structure subsidized industries will retard the rate of growth of new firms. In a regulated structure subsidized industries will push for complements; that is, airlines will push for airports, and will suppress substitutes;

railroads will press for higher weight limits on trucks that serve only one railroad station. As Mr. Posner notes, regulation is used to build up an infra-structure to promote growth that economic motives would not otherwise establish. For instance, regulation often denies geographic and density considerations, resulting in internal subsidies.

The internal subsidies provided by regulated industries perform allocative chores like the tax system. In this case the power of the state forces certain cost and pricing allocations: for instance, telephone rates are statewide; airline rates proportional to distance; flat rates for urban transit system; and postal rates do not reflect costs. Each of these rate structures represents an internal subsidy where prices do not reflect equally the cost of service. Given such internal subsidies, controls over entry are necessary due to the false pricing involved. Not coincidentally, regulated industries usually provide services because otherwise those for whom the internal subsidy was intended would be able to resell it. Mr. Posner¹⁷ cites a number of arguments against internal subsidies:

- . Congress relinquishes a great deal of taxing power to agencies.
- . These numerous subsidies cause dislocations which are hard to measure.
- . Equity. Moral redistributive power of the state are subject to misunderstanding and abuse.
- . Enforcement of internal subsidies is difficult because firms tend to cheat on the provision of services not adequately remunerative.
- . Internal subsidies have low visibility.
- . The management of regulation is a very difficult task. Once regulation is established there are no clear-cut standards for balancing distributive benefits against cost. Multiple and conflicting standards may lead easily to corruption. After several years of regulation there is little accurate market information upon which to base subsidy costs or allocative decision.

The regulatory management problem is compounded even further when a regulated industry has many borders with the free market.¹⁸ If the regulated industry has an absolute monopoly, determination of prices and costs are relative straightforward even if the criteria may lead to internal inefficiencies. Even in this limited regulatory environment, the insurance of the goals of regulation require, in addition to the specification of the rate of return, at least specification of the following:¹⁹

- . Price structure
- . Marketing methods
- . Competitive tactics
- . Minimization of costs and efficiency production
- . Service quality
- . Investment methods and financial management
- . Innovation and technical choices
- . Purchasing policies
- . Employee relations with composition of labor force, wage rates
- . Structural organization

When a regulated industry has many boundaries with non-regulated industry the problems are much worse. There must be controls over entry to prohibit cream-skimming due to internal subsidies. There must be constant consideration of the entire structure of the industry and its relations with all boundaries in order to maintain the desired rate of return for the subsidized and regulated industry while attaining the goals of regulation. The more boundaries the more complicated the decisions about what income gets included in computation of fair rate of return, what aspects come under intense regulation, what innovations or structural changes should be eligible for regulation, etc.

APPENDIX II FOOTNOTES

1. Urban Mass Transportation Administration, "Feasibility of Federal Assistance for Urban Mass Transportation Operating Costs."
2. William Tye, "The Capital Grant as a Subsidy Device: The Case Study of Urban Mass Transportation" in Joint Economic Committee, The Economics of Federal Subsidy Programs. Washington: U.S. Government Printing Office, 1973. Part 6, Transportation Subsidies, pp. 796-826
3. Lyle C. Fitch and Associates in connection with the Institute of Public Administration, Urban Transportation Public Policy, cited in William Tye, op. cit.
4. William Tye, op. cit.
5. William Tye, op. cit.
6. William Tye, op. cit.
7. "Feasibility of Federal Assistance....," op. cit.
8. William Tye, op. cit.
9. See Stanley S. Surrey, "Tax Subsidies as a Device for Implementing Government Policy: A Comparison with Direct Government Expenditures" in Joint Economic Committee, op. cit., Part I, General Study Papers.
10. Daniel Holland, "An Evaluation of Tax Incentives for on the Job Training of the Disadvantaged," The Bell Journal of Economics and Management Science, Vol. II, No. 1.
11. See Emile Sunley, Jr., "The Federal Tax Subsidies of the Timber Industry," in Joint Economic Committee, Congress of the U.S., The Economics of Federal Subsidy Programs, Part III, Tax Subsidies.
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APPENDIX III: HISTORICAL AND TECHNOLOGICAL CHARACTERIZATION OF THE PAPER INDUSTRY

Historical Developments of the Paper Industry

The paper industry was shaped over time by two main factors: first, the constant search for papermaking fibers and second, slow technological changes. From China, where it originated, to America, the art of papermaking traveled with many conquerors and adventurers.

Historical Summary

The Chinese, around 105 A.D., appear to have been the first to use plant fibers to make paper.¹ Although papyrus (from which the name paper is derived) was used several thousand years BC by the Egyptians and early Greeks, it cannot be considered as paper. Indeed, paper is a sheet formed from a water suspension of loose fibers, while papyrus was made by pasting together long strips of a reed (cyperus papyrus). It was not before 704 A.D. with the capture of Samarkand, that the Arabs learned from the Chinese the art of papermaking.² Before the end of that century, several papermills had been built in Bagdad³; and papermaking was a state monopoly for the next five hundred years.⁴

The secret of papermaking passed into Europe through trade routes and the Moorish conquest of Spain in the XIII Century.⁵

In Europe, early development of papermaking was opposed by the guild of parchment makers whose product was the preferred material for important documents and books.⁶ It was not before the second part of the XVI century and early XVII century that papermaking had captured the European world. The art of making paper crossed the Atlantic with William Rittenhouse, who built the first American papermill near Philadelphia in 1690.⁷ Throughout the colonial period, the American paper industry was characterized by a short supply of fibers (rags at that time) and bad quality paper. The first mill in New England was built in 1730,⁸ at which time there were still only three small mills operating in the colonies.⁹ By 1810, the census showed about 180 paper

mills in the U.S., most of which were small in size, producing in that year 3,000 tons of paper and board.¹⁰ It was only after the Civil War that the paper industry expanded very rapidly, due essentially to access to new sources of fibers (from wood) and the development of new papermaking technology. Based on the census of 1870 there were 667 paper mills in the U.S., employing 17,910 persons. At the turn of the 20th century, total production of paper and board was more than 2.2 million tons per year.¹¹

Table III-1 illustrates current paper and board production. Appendix Table III.1. shows the increase in pounds/capita as well as the constant consumption relation to GNP.

The Search for Fibers

The secret of papermaking from a vegetable substance,¹² while known to the Chinese, was only rediscovered during the XIX century. Until that time, linen and cotton rags were the primary source for fibrous raw materials.¹³ For instance, the first paper made in America was made from linen rags in 1690.¹⁴

Scarcity of rags was a principal reason for the slow development of papermaking in America. The public zeal was encouraged through advertisements and even poems, such as the following, printed in 1769 in the Boston News Letter:

Rags are as beauties, which concealed lie,
But when in paper how it charms the eye;
Pray save your rags, new beauties to discover
For paper, truly, every one's a lover:
By the pen and the press such knowledge is displayed,
As wouldn't exist if paper was not made.
Freedom of things, mysterious, divine,
Illustriously doth on paper shine.¹⁵

Paper was so scarce that in 1823 Congress was using paper with a French water mark, "Napoleon Empereur et Roi, 1813."¹⁶

Throughout the XVIII century efforts were made to discover substitute fibers for rags. In 1719, René de Reaumur presented to the French Royal Academy an essay in which he perceived that paper might be produced from wood. "Observing that the fabric of wasps' nests was procured from wood, he took the hint, and explaining his own conceptions on the subject, desired that some one of those who had an opportunity should make the experiment."

Appendix Table III.1. APPARENT CONSUMPTION OF ALL
GRADES OF PAPER AND PAPERBOARD^a

Year	Pounds per Capita	1,000 tons per bil. dlrs. real GNP
1899	57.9	
1904	73.7	
1909	90.8	
1914	108.8	
1919	119.6	
1924	162.6	
1929	220.3	
1934	178.6	
1939	243.7	
1944	281.6	
1947	343.4	79.9
1948	355.9	80.6
1949	331.0	76.2
1950	381.1	81.7
1951	394.6	79.7
1952	368.3	73.4
1953	391.6	76.0
1954	385.0	77.1
1955	418.5	79.3
1956	432.2	81.8
1957	410.1	77.9
1958	401.6	78.5
1959	435.5	81.4
1960	433.3	80.3
1961	439.0	81.1
1962	452.7	79.7
1963	462.1	79.3
1964	483.6	79.8
1965	505.6	79.5
1966	536.2	80.0
1967	522.8	76.9
1968	554.7	78.8
1969	581.4	81.3
1970	563.8	80.2
1971P	566.6	79.3

^a Source: American Paper Institute, "The Statistics of
Paper 1972," June, 1972, p. 32.

It was not until 1756 that the first attempt to manufacture paper from straw was made in Germany.¹⁸ Thirty years later, in London, a book was printed on paper made from the bark of a lime tree.¹⁹ Thereafter, paper makers tried to use various other vegetable substances (e.g., leaves) as sources of raw fibrous material.

Waste paper appears to have been first used in papermaking in 1790 by an Englishman, Samuel Hooper, "who produced paper of various quantities from leather cuttings and refuse paper."²⁰ In 1800 another Englishman, Matthias Koops, was producing 700 reams per week of clear and white paper from waste paper.²¹

Throughout the XIXth century, new methods for using fibers from softwoods, hardwoods, and finally even sawdust and shavings,²² were developed. At the turn of the XXth century, rags represented less than 9 percent of the materials consumed in the manufacture of paper and board in the U.S.²³

Appendix Table III.2 illustrates the increasing use of wood pulp as a fiber input to paper and board, with waste paper and rags declining. As reflected in Appendix Table III.3 this is a result of innovations which allowed the kraft pulping of hardwood and of wood residues like sawmill waste. The further effects of these innovations are illustrated in Appendix Table III.4, showing the declining significance of imports. Conservationists in the 1920's were very concerned that the high import levels implied an imminent timber famine, but sulphate pulping and its extension to residues reversed the trend.²⁴

Technological Developments

New processes and machinery have been very slow to develop. The first important technological improvement was the development of the Holland Beater, named after the country of its origin. The purpose of this machine was to reduce rags to fibers more rapidly than conventional methods. It appeared in Europe after 1725, and entered America fifty years later.²⁵

The second important improvement was the switch from manually laid molds to brass woven screens to produce paper during the second part of the XVIII century.²⁶ The production of pure white papers was made possible by a German chemist, Karl Wilhelm Scheele, who discovered chlorine in 1774, and Berthellot, a Frenchman, who discovered the bleaching action of chlorine gas.²⁷

Appendix Table III.2. FIBROUS MATERIALS CONSUMED IN U.S. PAPER AND BOARD MANUFACTURE^a

	(percent)				
	Wood pulp	Waste paper	Rags	Other	Total
1919	60.7	28.0	4.2	7.1	100
1929	54.3	33.2	6.4	6.1	100
1939	61.0	30.8	3.3	4.9	100
1944	56.0	36.6	2.3	5.1	100
1946	58.3	35.1	1.9	4.7	100
1947	58.2	35.1	2.0	4.7	100
1948	61.5	32.0	2.0	4.5	100
1949	63.6	30.8	1.8	3.8	100
1950	63.7	30.7	1.7	3.9	100
1951	62.7	32.1	1.4	3.8	100
1952	65.5	29.9	1.2	3.4	100
1953	65.6	30.0	1.1	3.3	100
1954	67.7	28.0	1.1	3.2	100
1955	67.4	28.4	1.1	3.1	100
1956	68.9	26.5	.9	3.7	100
1957	70.1	26.5	---	3.4	100
1958	69.9	27.0	---	3.1	100
1959	70.8	26.5	---	---	100
1960	72.0	25.3	---	---	100
1961	72.9	24.6	---	---	100
1962	74.0	23.5	---	---	100
1963	73.5	23.4	---	---	100
1964	75.5	22.3	---	---	100
1965	75.4	22.7	---	---	100
1966	76.2	21.8	---	---	100
1967	77.4	20.7	---	---	100
1968	78.8	19.5	---	---	100
1969	78.7	19.7	---	---	100
1970	79.2	19.3	---	---	100
1971 (P)	78.5	19.8	---	---	100

^aSource: Percentages through 1969 calculated from Census data by American Paper Institute in Wood Pulp Statistics, 36th Edition. 1970-1971 calculated by author based on Census Series "Current Industrial Reports" M26A(13), 1971, 1972.

Appendix Table III.3. WOOD PULP DOMESTIC PRODUCTION ^a

Year	Percent of Wood Pulp Total		
	Roundwood		Residues
	Softwood	Hardwood	
1950	83	13	4
1955	75	17	8
1960	64	20	16
1961	60	20	20
1962	57	21	22
1963	56	21	23
1964	55	22	23
1965	56	21	23
1966	53	22	25
1967	53	20	27
1968	52	20	28
1969	50	20	30
1970P	52	19	29
1971P	51	19	30

^aSource: U.S. Department of Agriculture, Forest Service, "The Demand and Price Situation for Forest Products 1971-1972." Miscellaneous Publ. No. 1231. (July 1972), p.74. Percentages calculated by author based on cordage.

Appendix Table III.4. IMPORTS AS A PERCENT OF PULP-
WOOD CONSUMPTION ^a

Years	Percent
1910	22.8
1920	20.3
1930	22.0
1940	10.5
1945	9.2
1950	6.0
1955	5.3
1960	3.4
1965	2.3
1970P	1.7

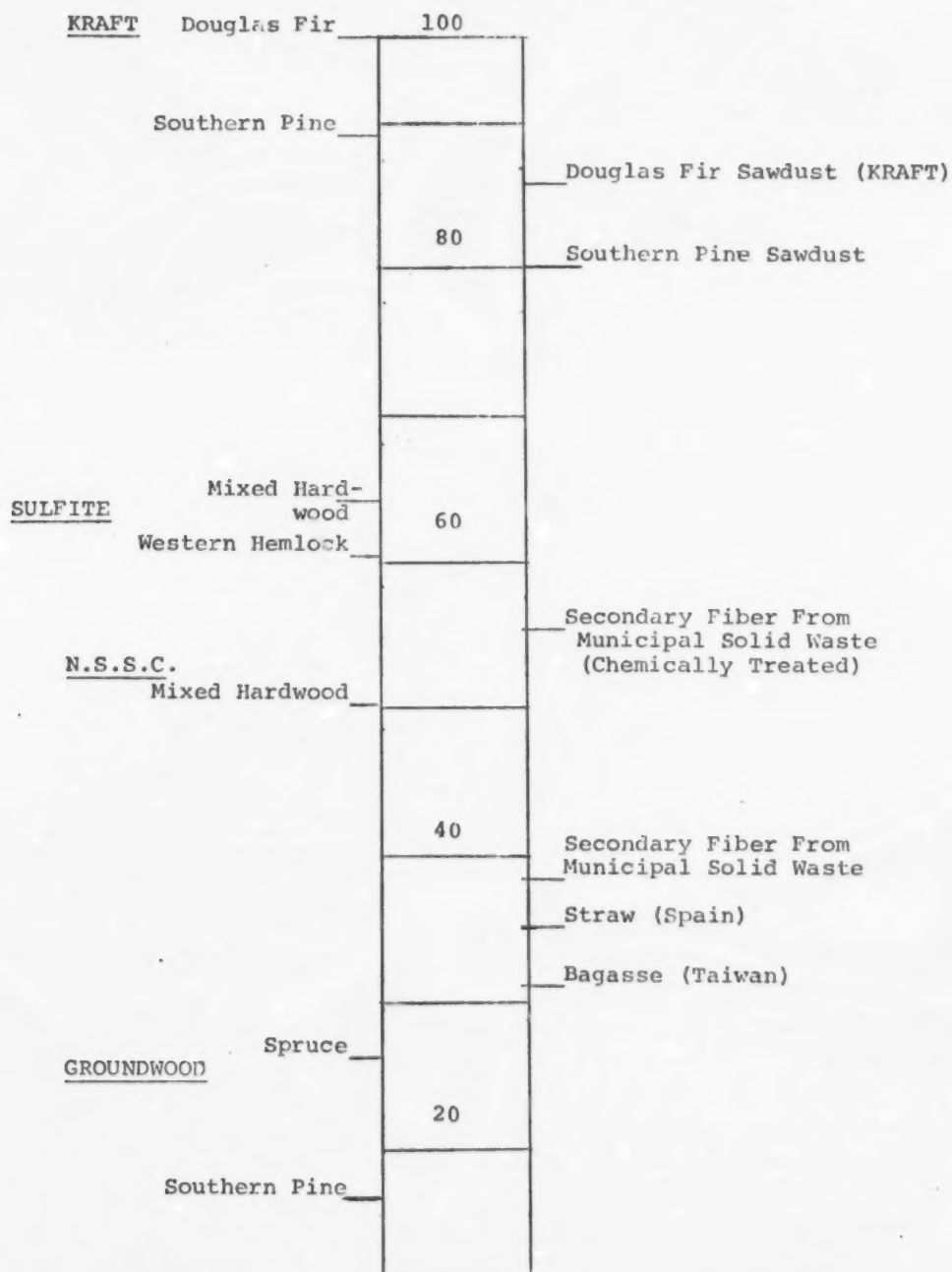
^aSource: U.S. Department of Commerce, Bureau of the Census
in American Paper Institute, Wood Pulp Statistics,
(New York: American Paper Institute, 1972), p. 84.

Until 1798 the actual formation of the paper sheets was mainly a hand process. That year Nicolas Louis Robert of the Essonnes Paper Mills invented a machine for making paper in lengths of 12 to 15 meters.²⁸ Due to financial and other difficulties, his patent rights finished in the hands of two prosperous London stationers, Henry and Sealey Fourdrinier, who financed the construction of the first English paper-making machine in 1803.²⁹ The two brothers spent their entire fortune improving the machine (which became known as the Fourdrinier machine), and ultimately died almost without means.³⁰ In 1809 John Dickinson invented the cylinder papermaking machine, and in 1821 steam heated dryers were added to the Fourdrinier machine.³¹ The paper machines used today are still essentially the same as they emerged 150 years ago.

At the same time the current manufacturing process was developing, rapid advance was made in the direction pointed out by Reaumur. The invention of efficient paper machines required that new sources of raw materials be found.

The groundwood process was developed after 1844.³² It consists of grinding logs against stone wheels to produce a pulp which retains practically all the impurity of the wood. In 1851 the first soda pulp was produced in England by boiling wood under the influence of caustic soda.³³ The soda process was patented in the U.S. in 1854, and used in a mill near Philadelphia in 1855.³⁴ In 1865 a chemist from Philadelphia, Benjamin Tilghman, produced wood pulp by digesting the wood with a solution of sulphurous acid and insulphites. But, it was only after 1886 that an improved sulphite process developed in Europe reached America.³⁵ The last fundamental development in pulping was introduced to the U.S. in 1909, and is known as the kraft, or sulphate, process.³⁶ Under this method wood chips are boiled with sodium sulphate to produce a brown pulp, stronger than sulfite. Although U.S. patents were granted to Eaton in 1870, the first industrial application was by the German Dahl, in 1879.³⁷

All these developments in paper chemistry were aimed at tapping new reserves of fibrous raw materials. First straw and bagasse were used, then softwoods (ground wood and soda processes), and finally hardwoods (kraft process). Underlying these developments was the constant search for dependable sources of cheap fiber. When a new source became technologically feasible, development progressed toward the goal of maximizing fiber length and paper properties compatible with more end products. Appendix Figure III.1



Appendix Figure III.1. Strength Factors of Various Pulps. Source: Walter F. Carr. "Many Problems Involved in Increasing Utilization of Waste Paper." Paper Trade Journal, 5/17/71, p. 51.

indicates the relative strengths of different pulps. Since pulps have many complex characteristics, looking only at strength is an oversimplification. But, the higher rated pulps can usually be placed in a larger range of products.³⁸

Current State of Wood Pulp and Paper Technology

Four major categories of activities can be defined in the fabrication of paper and board products: (1) harvesting; (2) pulping; (3) papermaking and (4) converting.³⁹ The process flow chart in Figure III-1 illustrates some of the critical activities required at each level. This section focusses on the current technological developments of the paper industry, presenting them in the simplest manner possible.

Technological developments will be discussed essentially for pulping and papermaking, the two most critical phases of the overall process. The harvesting of logs consists of very simple technology requiring little more than heavy moving and handling equipment. As for converting, which is the mechanical transformation of a sheet of paper or paperboard into a "paper product," no intrinsic changes in the paper specifications are performed.

The Pulping Process for Virgin Fibers

Pulping consists essentially in the conversion of logs and woodchips into separate fibers. The output of this process is a slurry of pulp fiber called "stock." Three basic methods of pulping are: (a) mechanical; (b) chemical; and (c) a combination of both. Appendix Table III.5 illustrates the trends.

Mechanical Pulp

There are two basic mechanical pulping methods: groundwood stone and groundwood chip. Groundwood stone, or stone grinding, has been in use for more than 100 years. It consists of the grinding, in a single operation, of softwoods and some low density hardwoods on abrasive pulpstones. This process has a very high yield of close to 100 percent, which can be explained by the fact that the end product, groundwood pulp, retains most of the lignin content of the logs (15 to 40 percent).⁴⁰ The introduction in 1924 of manufactured pulpstone,⁴¹ with controllable characteristics, increased the usage of this low cost pulping method.

Appendix Table III.5. U.S. PRODUCTION OF PULP BY MAJOR CLASSIFICATION
(000 tons)^a

	1899	1922	1940	1950	1960	1971	1971 percentage of production
Total ^b	NA	3,521	8,960	14,849	25,316	44,120	100
Groundwood	586	1,484	1,633	2,216	3,292	4,786	11.6
Sulphite, inc. diss. & sp. alpha	416	1,374	2,608	2,843	3,716	3,708	9.0
Sulphate	NA	244	3,748	7,501	14,590	28,819	70.1
Soda	177	420	532	522	102	167	.4
Semi-chemical ^c			165	686	1,991	3,641	8.3
All Other ^b	NA	1	274	1,075	1,307	--	--

^a Source: 1960 and earlier years: Bureau of the Census as reported by American Paper Institute Statistics of Paper 1964 p. 17, and 1971: Author's calculations based on data in American Paper Institute Wood Pulp Statistics 36th Edition, p. 56.

^b Excludes screenings after 1960.

^c Included in soda prior to 1940.

Groundwood Chip or chip refining, is a pulping method developed in the late forties and early fifties which uses chips or sawdust instead of logs. After the chips have been washed they are fed into one or more refiners which disintegrate them into separate fibers. The quality of groundwood chip pulp is comparable to groundwood stone, but pulp obtained from sawdust is somewhat inferior. Today, groundwood pulp is mainly used in newsprint grade paper because this pulp produces high quality paper in terms of better opacity and printability. But, mechanical pulping methods are essentially limited to softwoods (spruce, pine, Douglas fir, hemlock), thus restraining the overall output of groundwood pulp. In 1972, total production of groundwood pulp was approximately 4.2 million tons, i.e., 11.6 percent of total wood pulp produced.⁴²

Chemical Pulp

Most of the wood pulp produced today is manufactured by separating chemically the cellulose portion from the other constituents of wood. The process is quite simple, the critical elements being the active chemical ingredients used.

The woodchips of softwoods as well as hardwoods are charged into a pressure vessel, the digester, most often a vertical cylinder 50 feet high and with 20 tons capacity. The woodchips are packed as densely as possible into the digester and when it is filled the lead is closed and cooking liquor is pumped in. The mixture is heated and maintained at a temperature sufficiently high for the delignification reaction to take place. At the end of the cook the liquor is drained from the digester and the operation may start again. This simple explanation of the process is valid for the two basic methods of chemical pulping: sulphite and kraft, which account for 75 percent of the total wood pulp produced in 1972.⁴³

The sulphite process, first developed by Benjamin Tilghman in 1865, became the most important pulping method after 1890⁴⁴ because it permitted the pulping of wood previously unsuited to the mechanical process. Until 1950 the active ingredient used in the cooking liquor was calcium. Today, soluble bases of magnesium, sodium, and ammonium replace calcium to reduce the harm of liquor disposal into rivers and streams and facilitate the recovery of the cooking chemicals.⁴⁵ This acid pulping method offers a yield of 44 to 50 percent. In 1971, 5.9 percent of the wood pulp produced was sulphite pulp.⁴⁶

Over the last 50 years, the sulphite process has been displaced by the sulphate, or kraft process, an alkaline process, introduced in the U.S. in 1909, deriving its name from the Swedish word for strong. The main difference between the sulphite and kraft processes, as used today, is that the cooking liquor once drained from the digester is automatically fed into a kraft recovery system. The chemical ingredients, sodium sulfide and sodium hydroxide, which are much more expensive than those used for the sulphite process, are recovered; and the organic portion of the waste liquor is incinerated, thus creating a significant air pollution problem for kraft pulp mills. Another important difference between the two processes is that a sulphite cook takes much longer than a sulphate one, although the maximum temperature used is about the same (around 340°F.).⁴⁸

The kraft process has gained prominence because:

- a. it can be used to pulp all commercial woods
- b. it provides efficient and economical chemical recovery
- c. chlorine dioxide provides a cheap bleaching agent
- d. it generally produces superior strength properties, with only a slightly lower yield than the sulphite process.

Since its initial use, the kraft process "has been dominated to a high degree by technical innovation...built on empirical approaches."⁵⁰ Kraft pulp accounted for 70 percent of 1971 production as Appendix Table III.5 illustrates.

Semi-Chemical and Chemi-Mechanical Pulps

As their names indicate, these processes are a combination of the chemical and mechanical pulping. Semi-chemical processes offer a yield of 65 to 85 percent, close to that of chemical pulps, and are used mostly in corrugating medium. This process is often identified as the neutral sulphite semi-chemical (NSSC) pulping process. The hardwood chips are mildly treated with an acid sulphite, generally of sodium, and then mechanically defibrated.

The chemi-mechanical process has a higher yield (85 to 95 percent) than the semi-chemical process and produces pulp closer to groundwood pulp grades than chemical ones. This process, known as the neutral sulfite chemi-mechanical (NSCM) process, is of relatively recent development and is considered to be somewhat independent of semi-chemical pulping. The first U.S. mill installation was at the Gould Paper Company in 1955, using caustic soda as the chemical reagent.⁵¹ Most chemi-mechanical pulp is used in the fabrication of newsprint grade paper. In 1972, total production of semi-chemical and chemi-mechanical pulps accounted for 8.8 percent of the total wood pulp produced.⁵²

Bleaching, or chlorination, constitutes an extension of the pulping process whose purpose is to delignify and decolorize the pulp. The amount of chlorine required as well as the number of bleaching sequences depends largely on the method of pulping. For instance, sulfite pulp is more easily bleached than kraft pulp.

The Papermaking Process

The cellulose fibers produced by pulp mills generally undergo a last treatment before delivery to the paper machine. The last stage of beating or refining (depending upon the equipment utilized, i.e., beaters or refiners) transforms the fibers into a more desirable pulp in terms of the physical and aesthetic properties of the finished sheet of paper produced. This stage consists basically in a controlled loosening of the fiber structure to increase the common contact area among fibers. This increases the strength of the paper and produces a more homogeneous and smoother stock, the fibers being shorter and more flexible. Dying and sizing of the paper generally occur at this stage.⁵³ The solution, which is 99 percent liquid, can now be fed onto a paper machine.

A typical paper machine is composed of four main sections: the head box, the former, the press, and the dryer sections. The forming method used distinguishes paper machines into two major types: the fourdrinier and the cylinder type paper machines.

The head box, or inlet, provides the system with a constant flow of stock whose consistency of fiber in water suspension varies between 0.1 and 2 percent, thus the name "wet end"

of the machine. In the fourdrinier machine, the oldest and still most widely used forming method, the stock is deposited on an endless moving wire mesh. The fourdrinier table, which may be some 100 feet long and 30 feet wide, allows continuous drainage (by gravity and vacuum) of the stock. This open wire forming method is flexible, has a high drainage capacity, and is generally used at speeds up to 3000 fpm. In the cylinder machine, which operates at speeds up to 700 fpm, the stock is laid on a wire-covered cylindrical drum which most often rotates in a vat of stock.⁵⁴ The fiber web is subsequently picked off the drum by a belt which transports it to the presses. Several cylinders can be placed in tandem to produce sheets made of multiple layers of different grades of stock. For instance, the lowest grade stock, mixed waste paper, can be used as a "filler" which is then covered with a better stock, or "liner", (i.e., bleached sulfate). In addition, the color of the individual plies can be varied. The cylinder machine is particularly well adapted to the use of waste paper stock, but its speed (averaging 500 fpm) and width (150 in.) are limited. To manufacture lightweight sheets like tissue, high speed formers capable of up to 4000 fpm must be used. Suction breast roll formers are today the dominant former for tissue. New processes are being developed (e.g., twin wire formers) which will enable forming at speeds up to 5000 fpm without problems.

After the forming section the consistency of the sheet is only 10 to 25 percent solids. Presses are used to increase the solids content of the sheet of paper. As the paper leaves the press section it contains from 32 to 45 percent solids, depending on the forming method used. At this stage, the sheet enters the dryer section of the paper machine which consists generally of 40 to 70 drying cylinders for a typical fourdrinier machine, divided into top and bottom sections. Reducing the moisture content to about 7 percent requires about 8 million BTU's per ton of paper. This represents two thirds of all energy consumed in paper making.⁵⁶

Current State of Secondary Fiber Technology

During 1971, virgin wood pulp⁵⁷ accounted for 78.5 percent of all fibrous materials consumed in paper and board manufacture, recycled waste paper for 19.8 percent,⁵⁸ and other fibers, rags, etc. for the remainder.

The previous section discussed pulping and papermaking essentially in terms of virgin materials, although

Figure III-1 compared in flow chart form virgin and secondary processes. This section will outline some of the current technological developments in secondary fiber recycling and delineate problems associated with waste paper recycling.

The Recycling Process for Waste Paper

The pulping of virgin raw materials (e.g., roundwood, wood-chips) is done mechanically or chemically with a number of different processes. These processes are, however, unsuited for the recovery of fibers from waste papers. Secondary fibers differ from virgin ones in that they have already undergone pulping and are often contaminated with inks, clays or other substances. It is for these reasons that the term "repulping" appears appropriate.

Secondary fiber repulping systems have four basic stages: (1) defibering; (2) cleaning and screening; (3) washing; and (4) thickening. Depending on the final use of the waste paper stock, additional processing (e.g., bleaching and bleach washing) may be required.

The first step in the repulping process, defibering, is performed in a special unit where waste paper is mixed with water and chemicals. The mixture is subjected to violent agitation within a process which may operate on batch or continuous method. The consistency of the batch (6 to 8 percent), the temperature, the chemical concentration and the duration of the process are predetermined. The raw material used determines the chemicals and their concentration.

The cleaning stage consists generally of centrifugal cleaning to remove contaminants having greater specific gravity than wood fibers. The stock is then screened to remove all particles larger than the size of the screen's holes. At this stage the waste paper stock must be washed to remove inks, clays, chemicals, or other foreign substances in the stock. This process is often referred to as "deinking" and different methods are used,⁵⁹ the key parameters being water consumption and effluent treatment. Bleaching may be carried on during the initial defibering or during the deinking. Finally, thickening is required to provide working consistency to the stock. The waste paper stock is now ready to be fed directly onto the paper machine or mixed with virgin pulp. From this point on, the papermaking process is the one previously described for virgin fiber. It must be noted,

however, that paper machines are adjusted to a specific grade of stock (virgin, secondary fiber, or a combination), thus limiting considerably their short term flexibility in terms of substitutability of stock.

Aside from the differences which exist in the methods of converting virgin material and waste paper into pulp, there are specific characteristics associated with secondary fiber repulping systems. First, the capital investment for such a plant is much less on an absolute and per ton basis than for a virgin pulp plant; and second, the economic quantity is much smaller. In addition, the source of raw material shifts from rural (virgin pulp) to urban (waste paper pulp), thus having a direct impact upon the location of the pulp mill. Despite these advantages associated with a plant using waste paper as raw furnish, recycling has declined in percentage terms in the United States since the Second World War, from 36.5 percent in 1944 to 19.8 percent in 1971 of total fibrous materials consumed⁶⁰ (see Appendix Tables III.2, III.6, and III.7). Underlying this decline are economic, contextual and technological factors. The following section will discuss some of the technological factors limiting recycling of waste paper.

Technological Factors Limiting Recycling

Appendix Tables III.8 to III.10 show the breakdown of waste paper consumption in the U.S. There are four key technological factors behind the figures: (1) heterogeneity of waste paper grades; (2) level of contamination; (3) complex mix of fiber characteristics and substitutability; and (4) current plant design.

Heterogeneity of Waste Paper Grades

The Paper Stock Institute of America⁶¹ defines 46 different grades of "regular" secondary fibers plus 26 specialty grades.⁶² This wide variety of secondary fibers complicates the recycling process since the raw furnish determines the repulping process to be used.

The Level of Contaminants

One of the most important characteristics of waste paper is that it frequently contains contaminants which make it

Appendix Table III.6. CONSUMPTION OF FIBROUS MATERIALS
IN PAPER AND BOARD MANUFACTURE^a

(air dry tons)

	<u>Wood Pulp</u>	<u>Waste Paper</u>	<u>Rags</u>	<u>Other</u>	<u>Total</u>
1914	3,490,123	1,509,981	361,667	429,009	5,790,780
1919	4,019,696	1,854,386	277,849	470,393	6,622,324
1929	6,289,318	3,841,942	739,422	704,063	11,574,745
1935	6,442,178	3,587,390	501,589	467,360	10,998,517
1939	8,650,423	4,366,257	468,287	692,315	14,177,282
1940	9,781,739	4,667,502	402,600	640,967	15,492,808
1941	11,363,600	6,075,129	529,976	887,581	18,856,286
1942	11,038,020	5,494,959	480,614	844,337	17,857,930
1943	10,635,320	6,367,854	425,910	770,358	18,199,442
1944	10,502,204	6,859,332	427,837	957,389	18,746,762
1945	10,825,412	6,799,683	414,083	929,453	18,968,631
1946	12,092,093	7,278,097	402,506	979,755	20,752,451
1947	13,252,924	8,009,052	462,388	1,063,161	22,787,525
1948	14,374,586	7,584,501	415,668	1,036,044	23,410,799
1949	13,635,957	6,599,606	381,915	833,174	21,450,652
1950	16,508,905	7,956,036	441,894	957,444	25,904,279
1951	17,736,970	9,070,554	387,843	1,069,159	28,264,526
1952	17,286,030	7,881,193	324,560	886,556	26,378,339
1953	18,683,543	8,530,662	325,154	929,461	28,468,820
1954	18,989,159	7,856,637	316,737	882,955	28,045,488
1955	21,453,766	9,040,768	340,353	1,000,060	31,834,947
1956	22,998,380	8,836,449	298,259	1,253,070	33,386,158
1957	22,459,420	8,493,109	---1,105,475---		32,058,004
1958	22,483,118	8,670,824	---1,003,335---		32,157,277
1959	25,155,362	9,414,153	--- 979,457---		35,548,972
1960	25,700,031	9,031,614	--- 970,940---		35,702,585
1961	26,682,863	9,017,749	--- 894,257---		36,594,869
1962	28,598,333	9,074,815	--- 962,918---		38,636,066
1963	30,219,885	9,612,815	---1,284,715---		41,117,415
1964	32,087,548	9,843,489	--- 928,586---		42,859,623
1965	34,006,285	10,231,163	--- 879,000---		45,116,448
1966	36,922,186	10,563,857	--- 980,362---		48,466,445
1967	36,993,999	9,888,133	--- 836,000---		47,718,132
1968	41,302,856	10,221,745	--- 904,751---		52,429,352
1969(R)	43,699,831	10,939,151	--- 877,839---		55,516,821
1970(R)	43,394,401	11,803,000*	--- 821,023---		56,018,424
1971(P) ^b	43,611,200	12,281,000*	--- 956,000---		56,848,200

^a Source: United States Bureau of the Census
"Current Industrial Reports Series M 26 A (13)". Early years
as noted from Bureau of Census by American Paper Institute,
Wood Pulp Statistics, 36 Edition, New York, American Paper
Institute, 1972, p. 58.

^b (P) Preliminary

Appendix Table III.7. FIBROUS MATERIALS CONSUMED IN U.S. PAPER AND BOARD MANUFACTURE^a

Year	Wood pulp, percent				Waste paper, percent	Rags and other, percent	Total, percent
	Total wood pulp	Roundwood		Residues			
		Softwood	Hardwood				
1950	63.7	52.8	8.3	2.6	30.7	5.6	100
1971 (2) ^b	78.5	40.0	14.9	23.6	19.8	1.7	100

^a Source: 1950: Total wood pulp, waste paper, rags and other percentages calculated from census data by the American Paper Institute. Percentages within wood pulp are calculated by author based on cordage from statistics on domestic wood pulp production from the U.S. Department of Agriculture, Forest Service, "The Demand and Price Situation for Forest Products 1971-1972." Miscellaneous Publ. No. 1231. (July, 1972). p. 74.

^b 1971 (P): Total wood pulp, waste paper, rags and other calculated by author based on Bureau of the Census, Current Industrial Reports Series M26A(13), 1972.

APPENDIX TABLE III.8. WASTE PAPER CONSUMPTION BY GRADE OF WASTE PAPER

	1968		1969		1970		1971	
	Tons (000's)	Percent	Tons (000's)	Percent	Tons (000's)	Percent	Tons (000's)	Percent
Total Waste Paper ^a	10,222		10,939		10,594		10,996	
Mixed	3,130	30.6	3,213	29.4	3,140	30.0	3,254	29.6
News	1,995	19.5	2,198	20.1	2,073	19.6	2,073	18.9
Corrugated	3,254	31.8	3,558	32.5	3,511	33.1	3,511	31.9
High Grade Pulp Subs	1,322	12.9	1,419	13.0	1,377	13.0	1,377	12.5
High Grade Deinking	507	5.0	552	5.0	492	4.6	493	4.5
Total Waste Paper ^b			11,969		12,021		12,323	
Mixed			2,609	21.8	2,639	22.0	2,776	22.5
News			2,171	18.1	2,235	18.6	2,174	17.6
Corrugated			4,416	36.9	4,080	33.9	4,277	34.7
High Grade Pulp Subs			1,952	16.3				
High Grade Deinking			821	6.9	3,067	25.5	3,097	25.3

^a Figures in top rows are from U.S. Commerce Dept., Bureau of the Census Current Industrial Reports, Series M26A(13), 1969, 1970, 1971, 1972. Excludes molded pulp and paper machine broke. Data not available for earlier years.

^b Source: 1969 column from W.S. McClenahan, "Consumption of Paper Stock '91 U.S. Mills in 1969 and 1970," 1970. Figures include molded pulp products and converting trim but not wet or dry-end machine broke recycled within paper or board mills. Figures represent results of a 96 percent survey response of all capacity - 9.2% of figures are McClenahan's estimates. 1970, 1971, 1972 column from API Paper, Paperboard, and Wood Pulp Capacity surveys. API data includes wet and dry end paper board machine broke as well as use in molded pulp products. Use in molded pulp products represented 217,000 tons in 1970 (derived by comparing 12,021 with the figure given for waste paper use exclusive of molded pulp in API, Wood Pulp Statistics 36th Edition, 1972., p. 58). For 1971, the figure for molded pulp consumption is 42,000 tons out of 12,323,000 consumed according to API figures.

Appendix Table III.9. POST CONSUMER WASTE
AS PERCENTAGE OF CENSUS PAPERSTOCK GRADES,
1969^a

	PCW, percent	Prompt, percent
Mixed	72.0	28
News	96.1	3.9
Container	66.4	33
High Grade Pulp Subs.	20.6	70.2
High Grade Deinking	50.1	
	29.8	

^aSource: Author's calculation based on author's allocation of McClenahan's ("Consumption of Paperstock in U.S. Mills in 1969 and 1970") paperstock grades to PCW or prompt and McClenahan's 1969 correlation between his categories and Census categories. High grade de-inking percentage assumes an even split between PCW and prompt for those grades that contain both. The 29.8% combination of high grade pulp substitutes and high grade de-inking is a weighted average. See Appendix VI for correlation between waste categories and paperstock grades.

Appendix Table III.10. PERCENTAGE OF WASTE PAPER CONSUMPTION
BY WASTE PAPER GRADE, 1969^a

Paper Stock Grade ^b	Waste paper consumption as a percent of total paper-stock consumption	Post-Consumer Waste Y or N ^d (yes or no)
No. 2 Mixed Paper	3.7	Y
No. 1 Mixed Paper	10.0	Y
Super Mixed Paper	2.1	Y
Boxboard Cuttings	6.2	N
Mill Wrappers	0.1	Y
No. 1 News	11.6	Y ^e
Super News	4.5	Y
Over-Issue News	1.3	Y
Solid Fibre Containers	0.3	Y
Corrugated Containers	23.6	Y
New Corrugated Cuttings	3.1	N
New Double Kraft Lined Corrugated Cuttings	9.3	N
New Brown Kraft Corrugated Cuttings	0.6	N
No. 1 Used Brown Kraft Bags	0.2	Y
Mixed Kraft Bags	0.1	Y
No. 1 Brown Kraft Paper	0.3	Y
Super Sorted Brown Kraft	0.1	Y
New Colored Kraft	0.1	N
New Brown Kraft Cuttings	0.4	N
New Brown Kraft Bag Waste	0.4	N
New Brown Kraft Envelope Cuttings	0.3	N
Mixed Shavings	1.6	N
No. 1 Groundwood Shavings	0.7	N
White Newsblanks	0.9	N
Super White Newsblanks	0.1	N
Publication Blanks	0.5	N
No. 1 Flyleaf Shavings	0.9	N
No. 1 Soft White Shavings	0.6	N
Super Soft White Shavings	0.1	N
Hard White Shavings	0.5	N
Hard White Envelope Cuttings	0.8	N
Super Hard White Envelope Cuttings	0.1	N
New Colored Envelope Cuttings	0.2	N
Semi Bleached Envelope Cuttings	0.1	N
Super Semi Bleached Cuttings	0.2	N
Colored Tabulating Cards	0.5	Y
Manila Tabulating Cards	1.6	Y
No. 1 Sorted Colored Ledger	0.6	Y
Super Colored Ledger	0.9	Y ^d
No. 1 Sorted White Ledger	1.7	Y ^d
Super White Ledger	0.2	Y ^d
No. 1 Graded Magazines	0.3	Y
No. 1 Book Stock	0.5	Y ^d
Printed Bleached Sulphate Cuttings	0.9	N
Misprint Bleached Sulphate	0.4	N
Unprinted Bleached Sulphate	1.9	N
Converting Plant Trim and Miscellaneous	3.1	N
Kraft Side Rolls and Boxes	0.5	N
News Side Rolls	0.1	N
Polyethylene or Wax Coated Stock	1.2	Y
	100.0	
	65.2 of PCW ^c	

^aSource: Calculated from data in McClenahan, "Consumption of Paperstock by United States Mills in 1969 and 1970." 9.2 percent of waste represents estimates by McClenahan.

^bFull grade descriptions are in Appendix V.

^cAuthor's allocation of grade to PCW.

^dGrade contains PCW and prompt.

^eAssumes grades in 3 are half and half.

unusable in the manufacture of paper and board. Contaminants include such materials as adhesives, certain inks, asphalts, plastics, carbon papers, and foils.

The specifications of waste paper grades published by the Paper Stock Institute of America (Appendix V) indicate the maximum allowable percentages of undesirable materials in the particular grades which are purchased by the mill. The mills have the problem of sorting out remaining undesirable materials in the grades. Undesirable materials are classified into two categories for each grade: "prohibitive materials" and "outthrows". Prohibitive materials are any materials "which by their presence in a packing of paper stock, in excess of the amount allowed, will make the packing unusable as the grade specified"⁶³ and which "may be damaging to equipment." Outthrows are defined as "all papers that are manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified."⁶⁴ It should be noted that a material can be classified as an outthrow in one grade and as a prohibitive material in another grade. "Carbon paper, for instance, is 'UNSUITABLE' in #2 Mixed Paper and is therefore classified as an 'Outthrow'; whereas, it is 'UNUSABLE' in White Ledger and in this case is classified as a 'Prohibitive Material'."

One mill producing fine papers from various mixtures of virgin and secondary fibers has determined that acceptable drying cannot be obtained in certain coated grades when more than a minimal percent of secondary fiber is used.⁶⁵ In another case, the decreased drainage rate from the sheet on the wire due to shorter fiber length will not allow other machine components to operate at acceptable manufacturing speeds.⁶⁶

An operating problem encountered when using secondary fibers contaminated with heat sensitive materials (hot melts, plastics, etc.) is the adhesion of these materials to the dryer drums causing either poor quality paper or actual web breakage. The paper industry has developed emulsifiable oils and water dispersible compounds to combat this problem. For example, an emulsifier was developed to enable the release of toweling from Yankee drier drums. This action was necessary because the wet strength agents added to the pulp tend to gather unwanted materials and impart a tacky feel and a coating on the drier drum. That problem is a good illustration of how existing technological limitations may be solved if they are objectively defined and analyzed to present a logical path to practical solutions.

Complexity of Fiber Characteristics and Substitutability

Paper strength requirements and other fiber characteristics also cause technological manufacturing constraints in the use of waste paper. Dr. McKee from the Institute of Paper Chemistry has presented results illustrating the effect of successively reusing wastepaper on various strength measurements.⁶⁷ For certain high strength products, recycled paper furnishes are simply not acceptable. However, the matching of fiber characteristics and product requirements is a difficulty in virgin processes as well. Appendix Figure III.2 conveys an understanding of the complexity of this matching. (Appendix VII provides more complete fiber property data.) The task is made even more difficult when contaminants or misclassification are factors.

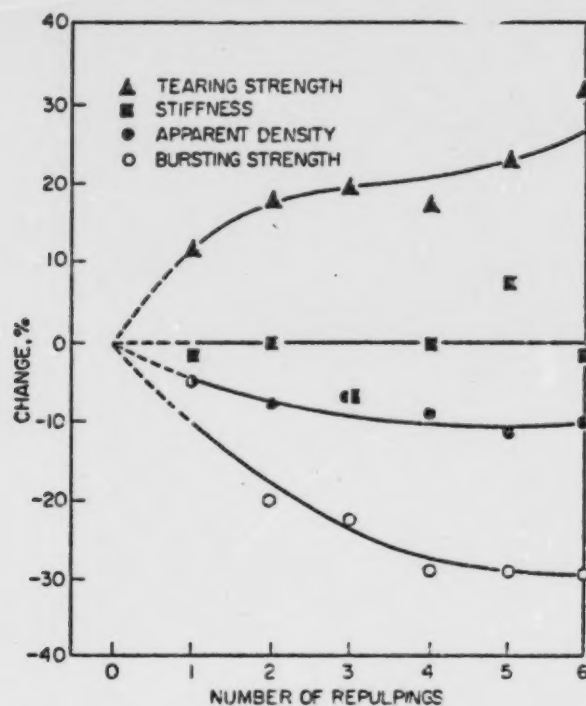
Repulping causes fiber degradation from both the mechanical and chemical repulping phases.⁶⁸ Sometimes the chemical effects carry over and interfere with internally added paper chemicals (sizing, for example).⁶⁹ Loss of bonding ability decreases as fibers are less able to absorb water and swell when in suspension.⁷⁰

Despite these limitations, secondary fibers offer several advantages, especially in terms of printability and opacity. Clouse lists several parameter advantages associated with recycled fibers: more uniform formation because of shorter fiber length; greater dimensional stability and reduced curl tendencies; increased bulk and softness; better size and filler retention, and lower power requirements since deinked fibers need only a minor brushing to produce well-formed papers.⁷¹

The implications are that secondary fiber may be determined technically advantageous or disadvantageous only by analyzing complex factors for the relevant production process and product use. Contamination, misclassification and a smaller body of research and experience provide absolute disadvantages.

Current Plant Design

True technological constraints, i.e., factors that make it either difficult or impossible to manufacture paper products from secondary fibers in a given situation, can be broken into two categories: type of equipment and capacity. These limitations are of prime importance to virgin mills



Appendix Figure III.2. Effect of Repulping on Bursting Strength, Apparent Density, Stiffness, and Tearing Strength of Virgin Unbleached Southern Kraft Pulp. Source: F.S. Crysler. "The Demand for Recycled Fibers". TAPPI. (June, 1971), p. 907.

desiring to utilize secondary fiber in their present operation.

A mill designed and constructed to process virgin pulp does not have the proper equipment to process non-prompt secondary fiber. While this situation can be changed in the long run, it is not reasonable to abandon high capital cost and efficient pulp mill equipment (digesters, chemical recovery plants, etc.) and replace it with equipment suitable to process secondary fibers (increased defibering, cleaning and screening capacity) simply to increase waste-paper recovery rates. Where excess papermill capacity relative to pulping capacity exists, some waste repulping may be economically sensible through the addition of secondary pulping facilities.

Appendix III Footnotes

1. Alexander Weaver, Paper, Wasps and Packages (Container Corporation of America, 1937), p. 12.
2. Ibid , p. 18.
3. Harry A. Maddox, Paper (Sir Isaac Pitman and Sons Ltd. 19), p.4.
4. Ibid., p.4.
5. Weaver, op. cit., p. 21.
6. Ibid., p. 24
7. Willem Ruddinghuysen, who later adopted the English form of William Rittenhouse, was a native of Broich in Holland. He was among the early settlers of Germantown, Pa.
Joel Munsell, Chronology of the Origin and Progress of Paper and Papermaking (J. Munsell, 1876) 5th Edition.
it is believed that he had followed his trade in Arnheim, Germany.
Weaver, op. cit., p. 38.
8. Munsell, op. cit., p. 37.
9. Lyman H. Weeks, History of Paper Manufacturing in the U.S. (Lockwood Trade Journal Co., 1916). p.
10. C. Earl Libby, Pulp and Paper Science and Technology (McGraw Hill Book Co., 1962), Vol. I, p.9.
11. American Paper Institute, "Statistics of Paper 1964", p.26.
12. The materials seem to have been the inner bark of the mulberry.
13. The Arabs probably used linen although Munsell, p.10, states that they introduced the art of manufacturing paper from cotton into Europe.
14. Munsell, op. cit., p. 33.
15. Ibid., p. 42.

16. Ibid., p. 75
17. Ibid., p. 35
18. Ibid., p. 39
19. Dard Hunter, Papermaking through Eighteen Centuries (William Edwin Rudge, 1930), p. 68.
20. Munsell, op. cit., p. 51.
21. Ibid, p. 55.
22. Munsell, p. 216, reports that in 1869 "Dr. Matthiessen of England, presented an improvement which consisted of . . . (using) sawdust and shavings . . . "
23. American Paper Institute, Wood Pulp Statistics 36th Edition, New York: American Paper Institute, 1972.
24. John Ziunuska, "The Role of Technology in Changing Wood Resources". TAPPI, June, 1969, p. 115.
25. Weaver, op cit., p. 48.
26. Maddox, op.cit., p. 11.
27. Ibid., p. 13.
28. Ibid., p. 8.
29. Ibid., p. 9
30. Ibid., p. 9.
31. Weaver, op. cit., p. 58.
32. Ibid., p. 58.
33. Edwin Sutermeister, The Story of Papermaking (R.R.Powker Co., 1954) p. 59.
34. Weaver, op. cit., p. 59.
35. Ibid, p. 59.
36. Ibid

37. Peter J. Kleppe, "Kraft Pulping". TAPPI. Jan, 1970. p. 35 .
38. Wayne F. Carr, "Many Problems Involved in Increasing Utilization of Waste Paper", Paper Trade Journal, May 17, 1971, pp. 48-52. p. 51.
39. These activities are fully catalogued by SIC code in Appendix I. Briefly: harvesting (08); pulping (261); paper and board making (262,263,266); and converted paper and board products (264,265).
40. Lignin is a polyphenolic cell constituent present in most plants. Its presence in paper causes it to yellow (i.e., newsprint made from groundwood pulp which has a high content of lignin).
41. James M. Perry, "Groundwood-Stone", in Handbook of Pulp and Paper Technology, (edited by Kenneth W. Britt, 2nd Edition, 1970) p. 180.
42. American Paper Institute, Wood Pulp Statistics, 36th Edition (American Paper Institute, Inc., 1972) p. 3.
43. Ibid., p. 3.
44. Refer to "Historical Developments of the Paper Industry."
45. The waste lignin recovery technology is only economically feasible for sulfite processes using ammonium and magnesium. For sodium the cost of recovery is still much larger than the value of the chemical.
46. Wood Pulp Statistics, op. cit., p. 3.
47. Refer to "Historical Developments of the Paper Industry."
48. Handbook of Pulp and Paper Technology, op. cit., p. 231.
49. Peter Kleppe, "Kraft Pulping". TAPPI. January, 1970, p. 36.
50. Ibid.

51. Handbook of Pulp and Paper Technology, op. cit., p. 197.
52. Wood Pulp Statistics, op. cit., p. 3
53. The term "sizing" is currently defined as "the process in which a chemical additive provides paper and paper-board with resistance to wetting and penetration, usually by aqueous liquids. Thus, sizing produces water repelency". from Handbook of Pulp and Paper Technology, op. cit., p. 355.

Sizing is sometimes used in a much broader sense to indicate the addition of almost any chemical agent to modify the properties of the paper product.

54. There exist many types of cylinder machines, the most common being the "wet vat" system where the drum rotates in a vat of stock. In the "dry vat" system, stock is only in contact with the drum for about one-third of its circumference. Yet, in other systems the stock is deposited directly on the drum. (Stevens and Kubayashe formers.)
55. Fred D. Ianazzi, Arthur D. Little, telephone conversation 11/28/73. Arthur D. Little has done a major study on energy consumption in papermaking.
56. Ibid.
57. Virgin wood pulps include pulps manufactured from roundwood and wood residues.
58. U.S. Bureau of the Census. "Current Industrial Reports", Series M 26A (13), 1972.
59. A. J. Felton in "Secondary Fiber" (Kenneth Britt, op. cit., p. 78) compares five methods used in the washing stage: vacuum cylinder, American disc filter, Lancaster washer, sidehill washer and flotation (the most controversial method).
60. Table, Consumption of Fibrous Materials in Paper and Board Manufacture.
61. The Paper Stock Institute of America is a commodity division of the National Association of Secondary Materials Industries, Inc. which publishes the paper stock standards and practices.

62. "Paper Stock Standards and Practices," Circular PS-72, effective August 1, 1972. See Appendix L for full list and description.
63. Circular PS-72, op. cit., p. 4.
64. Ibid., p. 4.
65. Robert McKee, "The Nature of the Reclaimed Fiber" in Proceedings of the First Waste Paper Symposium. pp. 12-17.
66. Ibid.
67. McKee, "Effect of Repulping on Sheet Properties and Fiber Characteristics." Paper Trade Journal. May 24, 1971.
68. L. D. Frattaroli, "Chemical Additives in Secondary Fibers Present and Future". TAPPI, 4th Annual Secondary Fiber Conference, pp. 139-145.
69. Ibid.
70. Ibid.
71. J. L. Clouse, in J.J. Forsythe, op. cit. 45(6); 176A(1962).

APPENDIX IV:

SIC DETAILED BREAKDOWN FOR PAPER AND BOARD
WITH 1971 CENSUS DATA ON PRODUCTION FROM
"CURRENT INDUSTRIAL REPORTS SERIES M 26 A (13) "

...PRODUCTION OF PAPER AND BOARD, BY GRADES: 1971 AND 1970

(Short tons)

SIC code	Grade	1971	1970
	ALL GRADES, TOTAL.....	35,091,530	33,316,171
	PAPER, TOTAL.....	23,837,840	23,634,961
	Printing, writing, and related papers, total.....	14,504,607	14,418,188
2621100	Newsprint.....	3,321,300	3,344,912
	Groundwood paper, uncoated, total.....	1,186,487	1,214,621
	Publication and printing:		
2621211	Grade A.....	354,862	401,187
2621212	Grade B.....	686,064	669,023
2621231	Body stock for coating ¹ :	(D)	(D)
2521232	Produced for shipments to establishments without papermaking equipment ² .	(D)	(D)
	Produced for own use or for shipment to establishments with papermaking equipment (not included in totals).....	(D)	(D)
2621233	Body stock for carbonizing ³	(D)	(D)
	Other converting and miscellaneous groundwood: ⁴		
2621251	Hanging.....	18,114	19,696
2621259	Other ⁵	127,427	124,715
31, and 33			
	Coated printing and converting paper, total ¹	2,350,694	2,275,610
	Coated printing and converting paper other than prime-coated body stock for further coating:		
2621310	Coated one side.....	379,583	403,225
2621330	Coated two sides ⁶	2,871,111	2,875,385
and 50			
	Prime coated body stock for further coating:		
2621350	Produced for shipment to establishments without papermaking equipment ² ..	(D)	(D)
2621380	Produced for shipment to establishments with papermaking equipment or for own use (not included in totals).....	193,312	210,336
	Book paper, uncoated, total.....	2,758,214	2,846,168
	Publication and printing.....	1,723,133	1,650,197
2621411	Plain, including M.F., E.F., antique, bulking, eggshell, and super-calcendered.....	163,792	166,140
2621412	Offset.....	1,546,473	1,466,829
2621419	Other book printing paper.....	12,868	17,228
	Book converting paper ¹	20,539	23,607
	Body stock for coating.....	20,539	23,607
2621430	Produced for shipment to establishments without papermaking equipment.	20,539	23,607
2621450	Produced for own use or for shipment to establishments with paper-making equipment (not included in totals).....	175,811	226,842
	Other converting and miscellaneous book paper.....	1,014,542	972,364
2621461	Envelope.....	477,412	472,199
2621462	Tablet.....	344,881	303,261
2621469	Other.....	192,249	196,904
	Bleached bristols, excluding cotton fiber index and bogus, total.....	976,244	997,109
2621510	Tabulating index.....	456,330	489,630
	Tag and file folder.....	276,940	271,792
2621531	Tag.....	204,474	199,814
2621532	Folder.....	72,466	71,978
	Other uncoated bristols.....	135,136	137,893
2621551	Index.....	106,576	111,857
2621552	Printing.....	23,786	22,490
2621553	Post card.....	2,774	3,546
2621560	Coated bristols.....	105,938	87,794
	Writing and related papers, n.e.c., total.....	3,011,668	2,936,768
	Writing, cotton fiber, including cotton fiber index.....	116,572	117,835
2621611	Bond and writing.....	80,867	81,999
2621612	Ledger.....	6,838	7,086
2621613	Onion skin and manifold.....	5,289	6,218
2621614	Papeterie and wedding.....	1,527	1,567
2621615	Body stock for communication, copying, and related papers.....	4,651	3,533
2621616	Other technical and reproduction paper.....	8,302	7,829
2621617	Index.....	4,875	4,917
2621619	Other.....	4,223	4,888

See footnotes at end of table.

...PRODUCTION OF PAPER AND BOARD, BY GRADES: 1971 AND 1970--Continued

(Short tons)

SIC code	Grade	1971	1970
	PAPER--Continued		
	Printing, writing, and related papers--Continued		
	Writing and related papers, n.e.c.--Continued		
	Writing, chemical woodpulp.....	2,421,806	2,337,790
2621631	Bond and writing, including protective check.....	869,768	870,407
2621632	Form bond in rolls.....	714,358	676,990
2621633	Ledger.....	50,916	49,316
2621634	Mimeograph, all woodpulp furnishes.....	134,001	134,816
2621635	Duplicator.....	199,408	175,172
2621636	Papeterie and wedding.....	50,876	56,607
2621637	Body stock for communication, copying, and related papers.....	146,790	143,243
2621641	Other technical and reproduction papers.....	94,569	92,987
2621643	Manifold.....	7,158	7,825
2621743	Opaque circular.....	13,708	17,503
2621649	Other, including colored school and construction papers.....	140,314	122,944
2621650	Cover and text.....	181,033	193,234
	Thin paper.....	292,257	287,919
2621671	Carbonizing free from groundwood pulp.....	182,671	179,166
2621672	Cigarette and condenser ²	109,586	108,753
2621679	Other (stencil, lens, etc.) ²		
	Packaging and industrial converting paper, total.....	5,457,576	5,438,790
	Unbleached kraft packaging and industrial converting paper, total.....	3,772,079	3,786,493
	Wrapping.....	285,871	297,668
2621711	All colored or natural brown M.F. and M.G. wrapping paper, including treated and untreated butchers' papers.....	275,432	285,977
2621719	Miscellaneous.....	10,439	11,691
	Shipping sack.....	981,570	995,581
2621731	Meeting minimum standards Federal Spec. UU-S-48 ²	981,570	995,581
2621739	Other unbleached kraft shipping sack paper ²		
	Bag and sack, other than shipping sack.....	1,910,362	1,897,693
2621751	Grocers bag and sack paper.....	1,817,034	1,794,483
2621759	Other unbleached kraft bag paper.....	93,328	103,210
	Other converting (18 pounds and over).....	594,276	595,551
2621781	Asphalting paper.....	152,994	154,474
2621782	Other creping.....	18,307	14,691
2621763	Envelope stock.....	(D)	(D)
2621764	Gumming stocks.....	89,917	87,602
2621785	Twisting and spinning stock (18 pounds and up).....	4,912	7,861
2621786	Waxing stock (18 pounds and up).....	(D)	(D)
2621789	Other converting.....	243,775	245,408
	Packaging and industrial converting paper, except unbleached kraft, total.....	1,243,824	1,231,137
	Wrapping.....	202,934	219,580
2621811	All M.G. and M.F. wrapping papers, treated and untreated butchers' papers.....	173,694	188,319
2621819	Miscellaneous wrapping.....	29,240	31,261
	Shipping sack, including combination kraft and rope bleached and semi- bleached.....	103,123	97,911
2621831	Rope and combination kraft and rope.....	38,879	17,830
2621839	Other shipping sack paper.....	76,244	80,081
	Other bag and sack.....	234,678	218,597
2621851	Grocers bag and sack.....	156,408	139,828
2621859	Other.....	78,270	78,771
	Other converting (18 pounds and over).....	494,339	491,788
2621861	Envelope stock.....	136,482	134,932
2621863	Gumming stock.....	13,361	(D)
2621862	Twisting and spinning stock (18 pounds and up).....	7,548	(D)
2621864	Waxing stock (18 pounds and up).....	183,604	183,783
2621868	Cup stock (under 90 pounds).....	37,847	37,413
2621889	Other, such as asphalting and creping stocks.....	134,497	134,533
2621880	Glassine, greaseproof, and vegetable parchment.....	308,750	303,283
	Special industrial paper, total.....	442,673	421,140
2621919	Abrasive paper.....	(D)	(D)
2621930	Cable paper.....	8,804	8,547
2621930	Electrical insulation and armature paper and paperboard.....	19,827	24,231
2621940	Pressboard including imitation pressboard.....	(D)	(D)
	Absorbent papers, total.....	46,462	44,341
2621951	Blotting paper.....	6,044	5,426
2621952	Filter paper.....	40,418	38,915
2621960	Matrix paper and board.....	8,621	9,989
2621970	Vulcanizing fiber stock.....	21,687	24,222
2621980	Resin impregnated stock.....	95,335	91,263
2621990	Other.....	218,441	190,911

See footnotes at end of table.

-PRODUCTION OF PAPER AND BOARD, BY GRADES: 1971 AND 1970--Continued

(Short tons)

SIC code	Grade	1971	1970
	PAPER--Continued		
	Tissue, total.....	3,875,657	3,787,983
	Sanitary paper.....	3,656,763	3,548,415
2621011	Toilet tissue.....	1,379,688	1,342,543
2621013	Single-ply.....	810,321	808,501
	Multi-ply.....	569,367	534,041
2621030	Facial tissue, other than toweling, napkin, and toilet.....	358,302	374,773
2621051	Napkin.....	387,834	374,238
2621053	Single-ply.....	301,372	289,474
	Multi-ply.....	86,462	84,764
2621060	Toweling, excluding wiper stock, but including facial tissue stock for towels.....	1,207,947	1,184,958
2621071	Sanitary napkin stock wadding.....	104,872	84,713
2621073	Wiper stock, regular, facial, and wadding type.....	80,667	51,206
2621079	Other sanitary stock.....	158,043	133,897
2621081	Tissue paper, excluding sanitary and thin.....	218,894	219,588
2621087	Wrapping tissue.....	50,930	48,614
2621083	Wadding tissue stock.....	81,112	55,354
2621085	Twisting tissue stock.....	13,744	13,833
2621086	Fruit and vegetable wraps.....	(D)	(D)
2621088	Pattern tissue stock.....	(D)	(D)
2621097	Creped wadding for interior packaging.....	40,380	43,240
2621099	Other tissue paper, excluding sanitary and thin.....	32,190	31,094
	PAPERBOARD, TOTAL.....	26,120,498	25,478,538
	Solid woodpulp furnish paperboard, total.....	19,157,827	18,445,306
	Unbleached kraft packaging and industrial converting paperboard, total.....	11,840,439	11,634,911
2631110	Unbleached linerboard.....	11,311,455	10,981,938
2631130	Corrugating medium ¹	(D)	(D)
2631150	Folding carton type board.....	(D)	(D)
2631170	Tube, can, and drum paperboard.....	171,061	184,372
2631190	Other unbleached packaging and industrial converting kraft paperboard.....	62,909	(D)
	Bleached packaging and industrial converting paperboard (85 percent or more bleached fiber).....	3,808,583	3,404,327
2631210	Folding carton type board.....	1,432,993	1,394,742
2631230	Milk carton board.....	979,539	971,031
2631250	Heavyweight cup stock.....	364,343	364,733
2631260	Plate, dish, and food serving stock.....	336,750	317,092
2631270	Linerboard.....	129,640	133,491
2631280	Tube, can and drum paperboard.....	(D)	(D)
2631290	Other bleached packaging and industrial converting paperboard.....	238,524	198,942
2631295	Solid groundwood pulp board.....	(D)	(D)
	Semichemical paperboard, total.....	3,716,533	3,418,188
2631310	Corrugating medium ¹	3,716,533	3,418,188
2631320	Other semichemical paperboard.....		
	Combination furnish paperboard, total.....	6,962,971	7,031,230
	Combination paperboard:		
2631410	Shipping containerboard, total.....	1,390,503	1,322,043
2631430	Linerboard.....	259,088	321,231
2631450	Corrugating medium ¹	879,231	916,338
	Container chip and filler board.....	252,184	284,496
2631510	Bending, total.....	2,637,101	2,726,831
2631530	Bending chip.....	748,184	766,137
2631550	Kraft-lined.....	80,283	92,522
2631570	White-lined.....	438,348	478,028
2631590	Clay coated.....	1,100,879	1,108,403
	Other combination bending paperboard.....	289,708	281,759
2631610	Nonbending, total.....	988,164	1,042,179
2631630	Plain chip.....	338,058	397,841
2631650	News-lined.....	191,515	211,393
2631670	White-lined.....	104,210	91,582
2631690	Other combination nonbending paperboard.....	344,383	341,671
2631730	Special combination packaging and industrial converting paperboard.....	1,937,203	1,739,127
2631750	Gypsum linerboard.....	836,045	804,608
2631770	Tube, can, and drum stock.....	608,610	573,747
2631790	Panelboard and wallboard stock.....	105,360	89,700
	Other special combination packaging and industrial converting paperboard.....	287,188	270,072

See footnotes at end of table.

--PRODUCTION OF PAPER AND BOARD, BY GRADES: 1971 AND 1970--Continued

(Short tons)

SIC code	Grade	1971	1970
	WET-MACHINE BOARD, TOTAL.....	137,825	139,055
2631810	Binder's board.....	(D)	(D)
2631820	Shoe board.....	43,803	43,864
2631890	Other wet-machine board.....	(D)	(D)
	CONSTRUCTION PAPER AND BOARD, TOTAL.....	4,995,387	4,275,629
	Construction paper, total.....	1,831,475	1,593,814
2661221	Sheathing paper (e.g., red rosin sheathing, asphalt sheathing stock, house sheathing).....	15,328	17,454
	Felts, saturating and dry:		
2661222	Roofing felts.....	1,478,262	1,314,055
2661224	Floor covering (e.g., carpet felt, floor covering felt stock, wet base for enameled floor covering and linoleum, etc.).....	115,631	84,847
2661226	Automotive felts.....	24,086	20,562
2661228	Other felts (e.g., deadening, industrial, pipe covering, refrigerator).....	29,998	23,774
2661231	Asbestos paper and asbestos filled paper (e.g., electrolytic paper) ^a	168,160	133,122
2661235	Flexible wood fiber insulation (insulating paper blankets) ^a		
2661239	Other building paper (e.g., saturating screenings) ^a		
	Insulating and hard pressed board, total.....	3,163,892	2,681,815
	Insulating board (for detail see below).....	1,445,835	1,218,531
	Hard pressed board (for detail see below).....	1,718,057	1,463,284

SIC code	Structural insulating board, density less than 31 pounds per cu. ft.	1971		1970	
		Short tons	Thousand sq. ft. 1/2" basis	Short tons	Thousand sq. ft. 1/2" basis
	Structural insulating board, total.....	1,445,835	3,838,953	1,218,531	3,193,714
	Insulating boards for the retail trade or for use directly in building construction, total.....	1,196,334	3,147,684	1,004,667	2,608,405
	Interior products, total.....	470,183	1,251,552	386,830	1,021,376
	Building board, 7/16" or thicker, mostly painted or factory finished.....	130,909	327,439	112,926	282,996
2661111	Wallboard, under 7/16" thick, except shinglebacker.....	23,247	57,829	26,756	70,492
2661113	Sound-deadening board, nominal 1/2" thick, natural finish.....	36,399	100,683	28,555	79,980
2661115	Tile, except acoustical.....	204,807	554,996	154,448	413,256
2661121	Acoustical tile and lay-in panels, acoustical.....	63,579	177,605	50,922	143,173
2661123	Other (including plank, trim, moldings, and other insulating board for retail or for use directly in interior building construction).....	11,242	33,000	11,223	31,479
	Exterior products, total.....	726,151	1,896,132	617,837	1,587,029
2661131	Sheathing board.....	559,902	1,438,930	436,306	1,074,829
2661133	Shinglebacker.....	17,168	46,782	18,004	47,008
2661135	Roof insulation board, preformed above deck.....	145,610	401,560	159,943	455,786
2661136	Insulating roof deck ^a	3,471	8,860	3,584	9,406
2661138	Insulating fiberboard formboard ^a				
	Insulating boards for industrial uses (for further manufacture, processing, or assembly), total.....	249,501	691,269	213,864	585,309
2661151	Insulating siding base.....	18,160	47,094	14,947	36,396
2661153	Trailer board.....	161,906	444,061	117,234	307,194
2661155	Backer board for siding made of metal ^a	69,435	200,114	81,683	241,719
2661157	Insulating board for processing into expansion joint strips ^a				
2661159	Insulating board for all other industrial uses such as automobile industry, furniture industry, etc. ^a				

SIC code	Hard pressed board, density 31 pounds or over per cu. ft.	1971		1970	
		Short tons	Thousand sq. ft. 1/8" basis	Short tons	Thousand sq. ft. 1/8" basis
	Hard pressed board, total.....	1,718,057	5,126,269	1,463,284	4,339,982
2499022	Treated or tempered.....	585,490	1,692,965	496,661	1,494,298
2499028	Not treated or tempered.....	1,131,567	3,433,304	966,623	2,845,684

(D) Withheld to avoid disclosing figures for individual companies.

^aFor the years since 1961 the method of compiling figures for uncoated groundwood paper, coated printing and converting paper, and uncoated book paper was changed. Accordingly, totals for these types of paper are not comparable with those for 1960 and earlier years. "Coated printing and converting paper" now includes all such paper (both machine coated and conversion coated) made in mills (primary) covered by the survey. The survey does not cover independent converters who do not make paper. Coating raw stock for conversion by paper mills included in this survey has been excluded from the uncoated groundwood and uncoated book totals in order that there may be no duplication in the figures. ^bCombined to avoid disclosing figures for individual companies. ^cIt is not possible to show corrugating medium data separately for each furnish without disclosing individual companies operations; however, the total tonnage of corrugating medium for all furnishes is 4,586,121 for 1971, 4,325,471 for 1970.

APPENDIX V:

Paper Stock (Waste Paper) Grade

Definitions of Paper Stock Institute of America , 1972

The grade definitions described are definitions intended to define grades as they should be packed and graded. CONSIDERATION SHOULD BE GIVEN TO THE FACT THAT PAPER STOCK AS SUCH IS A SECONDARY MATERIAL PRODUCED MANUALLY AND MAY NOT BE TECHNICALLY PERFECT.

Any reference in these definitions to the word "soft" shall refer to short fibered stock consisting of predominantly soda pulp and/or hardwood fibers.

Any reference to the word "hard" shall refer to long fibered stock predominantly sulphite or sulphate made of softwood fibers.

OUTTHROWS

The term "Outthrows" as used throughout this section is defined as "all papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified."

PROHIBITIVE MATERIALS

The term "Prohibitive Materials" as used throughout this section is defined as:

- a. Any materials which by their presence in a packing of Paper Stock, in excess of the amount allowed, will make the packing unusable as the grade specified.
- b. Any materials that may be damaging to equipment.

(See example under Section 9, Article IV)

Note: The maximum quantity of "Outthrows" indicated in connection with the following grade definitions is understood to be the TOTAL of "Outthrows" and "Prohibitive Materials."

A detailed list of most of the Prohibitive Materials and Outthrows that supplement and augment the Grade Definitions 38, 39, 40, 41, 42, 43, is available on request from Association Headquarters.

(1) #2 — MIXED PAPER

Consists of a mixture of various qualities of paper not limited as to type of packing or fiber content.

Prohibitive materials may not exceed.....2%

Total Outthrows may not exceed.....10%

(2) #1 — MIXED PAPER

Consists of a mixture of various qualities of paper, packed in bales weighing not less than 500 pounds and containing less than 25% of groundwood stock coated or uncoated.

Prohibitive materials may not exceed.....1%
Total Outthrows may not exceed.....5%

(3) SUPER MIXED PAPER

Consists of a clean sorted mixture of various qualities of papers, packed in machine-compressed bales not less than 60 inches in length and containing less than 10% of groundwood stock coated or uncoated.

Prohibitive materials may not exceed...1/2 of 1%
Total Outthrows may not exceed.....3%

(4) BOXBOARD CUTTINGS

Consists of baled new cuttings of paperboard such as are used in the manufacture of folding paper cartons, set-up boxes and similar boxboard products.

Prohibitive materials may not exceed... 1/2 of 1%
Total Outthrows may not exceed.....2%

(5) MILL WRAPPERS

Consists of baled wrappers used as outside wrappers for rolls, bundles or skids of finished paper.

Prohibitive materials may not exceed... 1/2 of 1%
Total Outthrows may not exceed.....3%

(6) #1 — NEWS

Consists of newspapers packed in bales of not less than 54 inches in length, containing less than 5% of other papers.

Prohibitive materials may not exceed...1/2 of 1%
Total Outthrows may not exceed..... 2%

(7) SUPER NEWS

Consists of sorted fresh newspapers, not sunburned, packed in bales of not less than 60 inches in length, free from papers other than news and containing not more than the normal percentage of rotogravure and colored sections.

Prohibitive materials.....None permitted
Total Outthrows may not exceed..... 2%

(8) SPECIAL NEWS DE-INK QUALITY

Consists of sorted, fresh, dry newspapers, not sunburned. Packed in bales not less than 60" in length, free from magazines, white blank, pressroom over-issues, and paper other than news, and containing not more than the normal percentage of rotogravure and colored sections. This packing must be free from tare.

Prohibitive materials.....None permitted
Total Outthrows.....1/4 of 1%

(9) OVER-ISSUE NEWS

Consists of unused over-run regular newspapers printed on newsprint, baled or securely tied in bundles, and shall contain not more than the normal percentage of rotogravure and colored sections.

Prohibitive materials.....None permitted
Total Outthrows.....None permitted

(10) SOLID FIBRE CONTAINERS

Consists of solid fibre containers having liners of either jute or kraft, packed in bales.

Prohibitive materials may not exceed.....2%
Total Outthrows may not exceed.....5%

(11) CORRUGATED CONTAINERS

Consists of corrugated containers having liners of either jute or kraft, packed in bales of not less than 54 inches in length.

Prohibitive materials may not exceed.....1%
Total Outthrows may not exceed.....5%

(12) NEW CORRUGATED CUTTINGS

Consists of baled corrugated cuttings having two or more liners of either jute or kraft. Non-soluble adhesives, butt rolls, slabbed or hogged medium, and treated medium or liners are not acceptable in this grade.

Prohibitive materials may not exceed.....1%
Total Outthrows may not exceed.....5%

(13) NEW DOUBLE KRAFT LINED CORRUGATED CUTTINGS

Consists of baled corrugated cuttings having all liners of kraft. Non-soluble adhesives, butt rolls, slabbed or hogged medium, and treated medium or liners are not acceptable in this grade.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(14) NEW KRAFT CORRUGATED CUTTINGS

Consists of baled corrugated cuttings having all liners of kraft. The corrugated medium must be either semi-chemical or other similar uniform medium. Non-soluble adhesives, butt rolls, slabbed or hogged medium, and treated medium or liners are not acceptable in this grade.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(15) #1 — USED BROWN KRAFT BAGS

Consists of baled brown kraft bags free of objectionable liners or contents.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1/2 of 1%

(16) MIXED KRAFT BAGS

Consists of baled used kraft bags free from twisted or woven stock and other similar objectionable materials.

Prohibitive materials may not exceed.....2%
Total Outthrows may not exceed.....5%

(17) SORTED BROWN KRAFT

Consists of baled clean sorted brown kraft papers free from twisted or woven stock, sewed edges and heavy printing. Bales must be 60 inches or more in length.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(18) NEW COLORED KRAFT

Consists of baled new colored kraft cuttings, sheets and bag waste, free of sewed or stitched papers.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

(19) NEW BROWN KRAFT CUTTINGS

Consists of baled new unprinted brown kraft cuttings or sheets entirely free from sewed edges, twisted or woven stock.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

(20) NEW BROWN KRAFT BAG WASTE

Consists of new brown kraft cuttings and sheets, including misprint bags. Stitched or sewed papers are not acceptable in this grade.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

(21) NEW BROWN KRAFT ENVELOPE CUTTINGS

Consists of baled new unprinted brown kraft envelope cuttings or sheets.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

(22) MIXED SHAVINGS

Consists of baled trim of magazines, catalogs and similar printed matter, not limited with respect to ground-wood or coated stock, and may contain the bleed of cover and insert stock as well as beater-dyed papers and solid color printing.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(23) #1 — GROUNDWOOD SHAVINGS

Consists of baled trim of magazines, catalogs and similar printed matter free from beater-dyed papers, and may contain not over 5% of solid color printing.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

(24) WHITE NEWSBLANKS

Consists of baled unprinted cuttings and sheets of white newsprint paper or other papers of white ground-wood quality, free of coated stock.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

(25) SUPER WHITE NEWSBLANKS

Consists of baled unprinted cuttings or sheets of white newsprint of uniform brightness and quality, free of coated stock.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1/2 of 1%

(26) PUBLICATION BLANKS

Consists of baled, unprinted cuttings, or sheets of white coated or filled white groundwood content paper.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

(27) #1 — FLYLEAF SHAVINGS

Consists of baled trim of magazines, catalogs and similar printed matter. It may contain the bleed of cover and insert stock to a maximum of 10% of dark colors, and must be made from predominantly bleached chemical fibre. Beater-dyed papers may not exceed 2%. Shavings of novel news or newsprint grades may not be included in this packing.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

(28) #1 — SOFT WHITE SHAVINGS

Consists of baled shavings and sheets of all-white sulphite printing papers, free from printing. This grade may contain sulphite and sulphate papers having a small percentage of groundwood.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

(29) SUPER SOFT WHITE SHAVINGS

Consists of baled shavings and sheets of all-white sulphite and sulphate printing papers of reasonably uniform brightness free from printing, but may contain not more than 5% of coated papers.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1/2 of 1%

(30) HARD WHITE SHAVINGS

Consists of baled shavings or sheets of all untreated white bond ledger or writing papers. Must be free from printing and groundwood.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1/2 of 1%

(31) HARD WHITE ENVELOPE CUTTINGS

Consists of baled envelope cuttings or sheets of untreated hard white papers free from printing and ground-wood.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1/2 of 1%

(32) SUPER HARD WHITE ENVELOPE CUTTINGS

Consists of baled cuttings or sheets of untreated white envelope papers of reasonably uniform brightness free from printing, groundwood and coated stock.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1/2 of 1%

(33) NEW COLORED ENVELOPE CUTTINGS

Consists of baled untreated colored envelope cuttings, shavings or sheets of bleachable colored papers, predom-

inantly sulphite or sulphate, free from all printing.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(34) SEMI BLEACHED ENVELOPE CUTTINGS

Consists of baled envelope cuttings, shavings or sheets of manila-colored papers predominately sulphite or sulphate, free from all printing.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(35) SUPER SEMI BLEACHED CUTTINGS

Consists of baled cuttings and sheets of untreated sulphite or sulphate papers free from printing.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1/2 of 1%

(36) COLORED TABULATING CARDS

Consists of printed colored or manila cards predominately sulphite or sulphate which have been manufactured for use in tabulating machines. Unbleached kraft cards are not acceptable.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

(37) MANILA TABULATING CARDS

Consists of printed manila-colored cards, predominately sulphite or sulphate, which have been manufactured for use in tabulating machines. This grade may contain manila-colored tabulating cards with tinted margins.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

(38) #1 SORTED COLORED LEDGER

Consists of printed or unprinted sheets, shavings, and cuttings of colored or white sulphite or sulphate ledger, bond, writing, and other papers which have a similar fibre and filler content. This grade must be free of treated, coated, padded, or heavily printed stock.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(39) MANIFOLD COLORED LEDGER

Consists of sheets and side trim of new printed or unprinted colored or white sulphite or sulphate papers such as are used in the manufacturing of manifold forms, continuous forms, register forms, and similar printed papers. Those forms used once for machine data processing may be included. All stock must be untreated and uncoated.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(40) #1 SORTED WHITE LEDGER

Consists of printed or unprinted sheets, shavings, and cuttings of white sulphite or sulphate ledger, bond,

writing, and other papers which have a similar fibre and filler content. This grade must be free of treated, coated, padded, or heavily printed stock.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(41) MANIFOLD WHITE LEDGER

Consists of sheets and side trim of new printed or unprinted white sulphite or sulphate papers such as are used in the manufacturing of manifold forms, continuous forms, register forms, and similar printed papers. Those forms used once for machine data processing may be included. All stock must be untreated and uncoated.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(42) #1 GRADED MAGAZINES

Consists of a mixture of dry, clean magazines only; free from newsprint magazines, pulpy magazines, novel news, comic books, pocket books, and all coarse or shiv papers. Movie magazines, television magazines, detective magazines and similar publications are not acceptable.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(43) #1 BOOK STOCK

Consists of bleached sulphite or sulphate papers, printed or unprinted in sheets, shavings, guillotined books, or quire waste. A small percentage of papers containing fine groundwood adulteration may be included.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....2%

(44) PRINTED BLEACHED SULPHATE CUTTINGS

Consists of printed bleached sulphate cuttings free from misprint sheets, printed cartons, wax, greaseproof lamination, gilt, and inks, adhesives or coatings that are non-soluble.

Prohibitive materials may not exceed.....1/2 of 1%
Total Outthrows may not exceed.....2%

(45) MISPRINT BLEACHED SULPHATE

Consists of misprint sheets and printed cartons of bleached sulphate free from wax, greaseproof lamination, gilt, and inks, adhesives or coatings that are non-soluble.

Prohibitive materials may not exceed.....1%
Total Outthrows may not exceed.....2%

(46) UNPRINTED BLEACHED SULPHATE

Consists of unprinted bleached sulphate cuttings, sheets or rolls free from any printing, wax, greaseproof lamination or adhesives or coatings that are non-soluble.

Prohibitive materials.....None permitted
Total Outthrows may not exceed.....1%

SPECIALTY GRADES

The grades listed below are produced and traded in carload and truckload quantities throughout the United States and because of certain characteristics (i.e. the presence of wet strength, polycoatings, plastic, foil, carbon paper, hot melt glue) are not included in the regular grades of paper stock. However, it is recognized that many mills have special equipment and are able to utilize large quantities of the grades listed below. Since many paper mills around the world do use these specialty grades, they are being listed below with appropriate grade numbers for easy reference.

The Paper Stock Institute is not establishing specific specifications, which would refer to such factors as the type of wet strength agent used, the percentage of wax, the amount of polycoating, whether it is on top of or under the printing, etc. The specification for each grade should be determined between buyer and seller, and it is recommended that purchase be made based on sample.

These specialty grades are as follows:

- 1—S White Waxed Cup Cuttings
- 2—S Printed Waxed Cup Cuttings
- 3—S Plastic Coated Cups
- 4—S Polycoated Bleached Kraft—Unprinted
- 5—S Polycoated Bleached Kraft—Printed

- 6—S Polycoated Milk Carton Stock
- 7—S Polycoated Diaper Stock
- 8—S Polycoated Boxboard Cuttings
- 9—S Waxed Boxboard Cuttings
- 10—S Boxboard Cuttings containing Foil
- 11—S Waxed Corrugated Cuttings
- 12—S Wet Strength Corrugated Cuttings
- 13—S Asphalt Laminated Corrugated Cuttings
- 14—S Beer Carton Waste
- 15—S Kraft Carrier Cuttings, Wet Strength Treated
- 16—S White Wet Strength Waste
- 17—S Brown Wet Strength Waste
- 18—S Printed and/or Colored Wet Strength Waste
- 19—S White Glassine
- 20—S Chocolate Glassine
- 21—S Red Glassine
- 22—S Printed and/or Mixed Colored Glassine
- 23—S Flyleaf Shavings containing Hot Melt Glue
- 24—S Manifold Ledger containing Carbon Paper
- 25—S Books with covers
- 26—S Manila and Colored Tabulating Cards in small boxes on skids—unsorted (rubber bands, clips, and correction stickers not removed; percentage of manila cards to be predetermined by buyer.)

APPENDIX VI
CLASSIFICATION OF PAPERSTOCK
INSTITUTE GRADES INTO CENSUS
CATEGORIES, 1972

Mixed: PS Grades 1-5

News: PS Grades 6-9 and 23

Container: PS Grades 10-14, includes corrugated and
solid fiber.

High Grade Pulp Substitutes: PS Grades 15-22, 24-37,
46.

High Grade Deinking : PS Grades 38-45.

Source: Author's allocation base on McClenahan.

"Consumption of Paper Stock by United States
Mills in 1969 and 1970".

APPENDIX VII

DETAILED DATA CONCERNING PROPERTIES OF
VIRGIN AND SECONDARY FIBERS

Appendix Table VII.1. EFFECT OF NUMBER OF PAPERMAKING CYCLES ON SHEET PROPERTIES
(Unbleached kraft finish)^a

Properties of Handsheets	Number of Repulpings									
	0a	1	2	3	4	5	6	7	8	9
Basis weight, g./m. ² air dry	63.8	63.4	65.0	65.1	65.0	67.5	66.1	66.1	66.1	66.1
Caliper, micron	109	114	122	124	127	127	127	127	127	127
Apparent density	0.585	0.556	0.553	0.525	0.512	0.531	0.523	0.508	0.508	0.508
Bursting strength factor, g./cm. ²	52.0	44.8	40.7	36.9	34.9	34.6	33.5	32.3	32.3	32.3
Tensile breaking length, meter	7130	6900	5690	5680	5630	5290	5190	5190	5190	5190
Stretch, %	3.2	3.0	2.9	2.6	2.4	2.5	2.5	2.6	2.6	2.6
Tearing strength factor, g./sheet	132	140	148	154	149	157	163	163	163	163
Taber stiffness factor	0.033	0.035	0.034	0.034	0.037	0.037	0.038	0.038	0.038	0.038
Schopper fold, no.	599	565	472	379	354	467	467	467	467	467
Porosity, sec./100 cc.	30	36	33	23	22	21	21	20	20	20
Zero-span tensile, kg./cm. for std. sheet	7.67	7.30	7.64	7.22	6.64	6.34	6.34	6.04	6.04	6.04
Bonding strength, kilopoise-cm./sec.										
Blister	300	192	153	170	146	107	92.3	92.3	92.3	92.3
Rupture	487	354	293	268	241	212	212	212	212	212
Bonded area, %	59.0	58.7	57.2	54.6	56.2	46.3	46.3	46.3	46.3	46.3
Swelling, %	220	193	169	159	159	154	154	141	141	141

^a Virgin pulp used in first cycle.

^a Source: Robert C. McKee. "Effect of Repulping on Sheet Properties and Fiber Characteristics".

Paper Trade Journal. May 24, 1971, pp. 34-40

Appendix Table VII.2. EFFECT OF FREENES LEVEL AND TYPE FIBER ON SHEET PROPERTIES^a

Handsheet Properties	Pulp Type:	Bleached Kraft				Groundwood ¹			
		600	450	300	110	Diff., %	Diff., %	Diff., %	Diff., %
Freeness, ml. (C.S.):									
Handsheet Properties									
Basis weight, g./m. ²	Virgin	66.6	66.6	64.5	65.0	0	0	65.0	0
Caliper, micron ²	Repulped	102	117	97.6	120	17.7	23.0	149	144
Density	Virgin	0.623	0.543	0.651	0.530	9.0	18.6	0.427	0.441
Bursting strength factor	Repulped	43.4	33.7	50.7	32.7	19.4	35.5	6.71	6.37
Tensile breaking length, m.	Virgin	6210	4910	7470	4920	20.9	34.1	1880	1680
Stretch, %	Repulped	2.6	2.7	2.7	2.8	7.7	3.7	1.1	1.1
Tensile energy absorption, g.cm./cm. ²	Virgin	70.6	84.1	87.5	62.1	25.1	29.0	8.86	7.98
Tearing strength factor	Repulped	132	165	158	146	117	40.4	21.5	19.6
Porosity, ml./min.	Virgin	1977	2766	462	607	39.9	631.0	644	595
Zero-span tensile, kg./cm.	Repulped	9.00	7.73	8.10	7.73	14.1	15.0	4.94	5.07
Opacity, %	Virgin	65.9	68.1	62.1	71.6	3.3	15.3	97.0	97.7
Brightness, %	Repulped	85.8	85.2	85.5	83.6	0.7	2.1	63.7	62.0
Z-direction tensile, kg./cm. ²	Virgin	8.76	6.77	12.6	7.32	22.7	41.9	4.07	3.15
* Adjusted to 63.54 g./m ² weight.									

^a Source: Robert C. Mckee. "Effects of Repulping on Sheet Properties and Fiber Characteristics". Paper Trade Journal. May 24, 1971, pp. 34-40

Appendix Table VII.3.

TEST RESULTS ON NEWSPRINT-COMPARISON OF VIRGIN NEWSPRINT VS. NEWSPRINT FROM 100%
DEINKED NEWSPAPERS^a

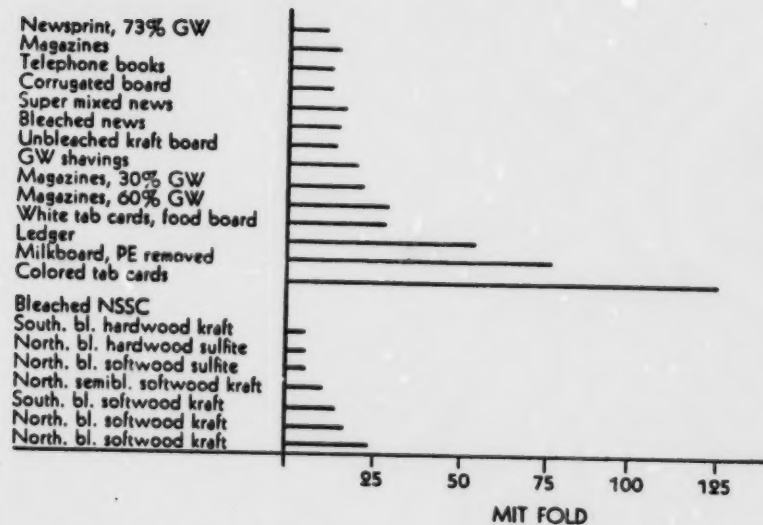
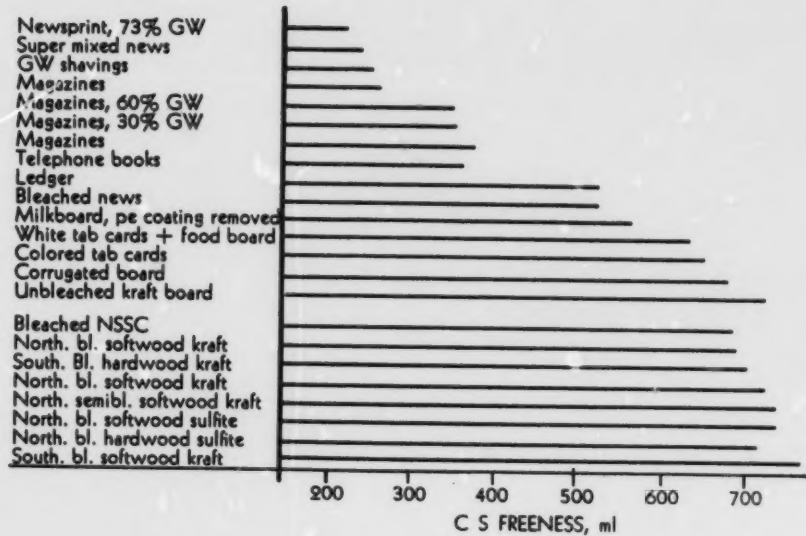
	Virgin newsprint samples from manufacturers in Northeastern U.S. and Eastern Canada										100% deinked stock
	A	B	C	D	E	F	G	H	I	Garden State Garfield	
Green reflectance (%)	64.4	69.1	67.0	67.5	64.5	64.7	65.4	66.2	66.5	No.1 No.2	
Blue reflectance (%)	65.6	67.8	66.4	67.1	63.5	63.9	66.4	64.9	65.4	64.8 64.7	
Printing opacity (%)	58.7	63.1	60.4	61.9	58.7	58.1	58.0	59.1	59.4	64.0 63.5	
Saturation (%)	57.4	62.3	59.8	61.1	57.0	56.9	57.5	57.2	57.4	58.9 58.9	
Dominant wavelength (mu)	95.2	95.6	96.3	96.4	96.1	96.5	96.5	95.4	96.5	96.2 96.9	
Caliper (mils)*	7.8	7.8	6.8	5.5	6.0	6.2	6.2	7.1	7.3	6.1 5.9	
Bursting strength (PSI)*	8.4	5.4	6.9	6.0	6.9	7.4	9.2	8.0	8.0	6.2 6.4	
Tear resistance (grs)*	580	579	582	579	580	580	581	579	581	580 578	
Tensile strength (lbs)*	2.88	3.65	3.19	3.14	3.72	3.62	3.33	3.37	3.44	578 578	
Basis weight (lbs./3000 sq. ft.)	12.5	8.6	7.6	3.6	3.9	8.7	9.0	10.2	7.7	3.28 3.40	
Tensile energy absorption (0.1 in. gr.)	22.6	32.0	21.9	22.0	23.9	23.1	21.8	23.9	25.6	7.0 7.9	
Stretch (%)	3.92	3.43	3.25	3.56	3.44	3.38	3.59	3.69	2.96	30.4 31.5	
Porosity-Gurley (sec./100 cc.)	31.8	31.9	33.3	33.9	32.6	34.4	32.7	32.3	33.3	30.1 31.9	
Softness-Gurley (sec./25 cc. -0.34 lb. wt.)	7.1	8.9	6.6	7.3	6.0	5.6	6.7	7.8	6.5	32.7 31.8	
Stiffness-Gurley	0.86	1.13	0.83	0.89	0.84	0.78	0.88	0.97	0.98	6.1 6.6	
	86	14	50	62	24	19	31	16	33	0.80 0.93	
	13	30	23	17	20	28	21	20	21	13 18	
	69	109	85	86	106	132	99	94	88	27 22	
	37	43	31	29	32	33	37	38	36	79 88	
										28 40	

* Physical test data corrected to 22.0 lbs./3000 sq. ft. basis weight

^a Source: "Secondary Fibers - Many Facets of Processing and Usage Explored".
PULP & PAPER. December, 1969, pp. 109-112.

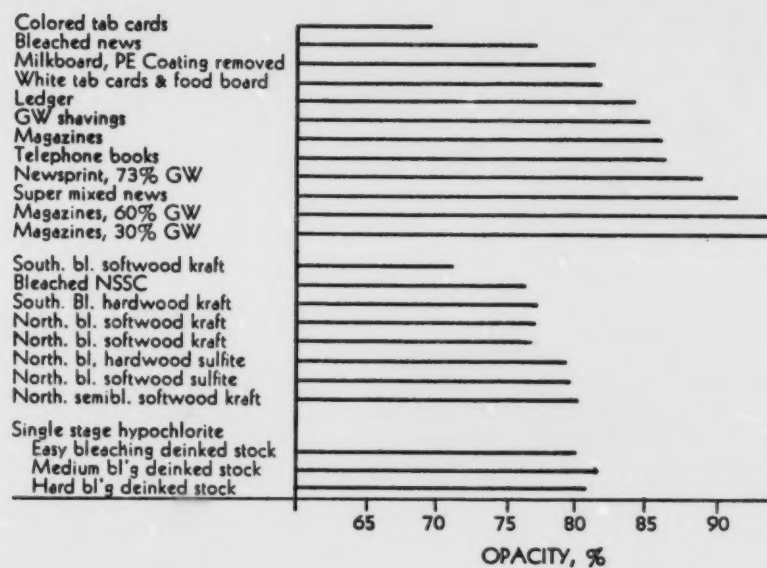
Appendix Figure VII.1.

FREENESS AND FOLD OF SECONDARY FIBERS

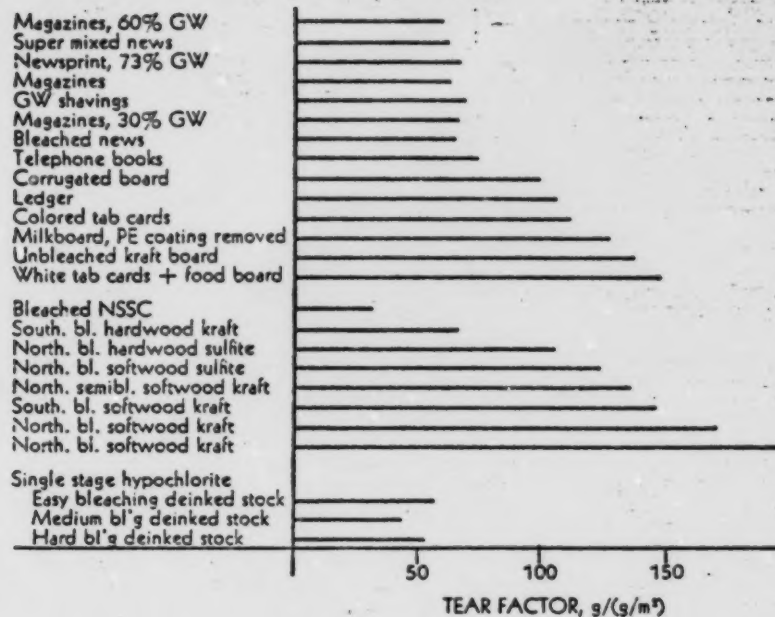


Source: Jurgen Kleinau. "Properties of Secondary Fibers".
TAPPI. July, 1966. pp. 90A-93A.

Appendix Figure VII.2.
OPACITY OF SECONDARY FIBERS

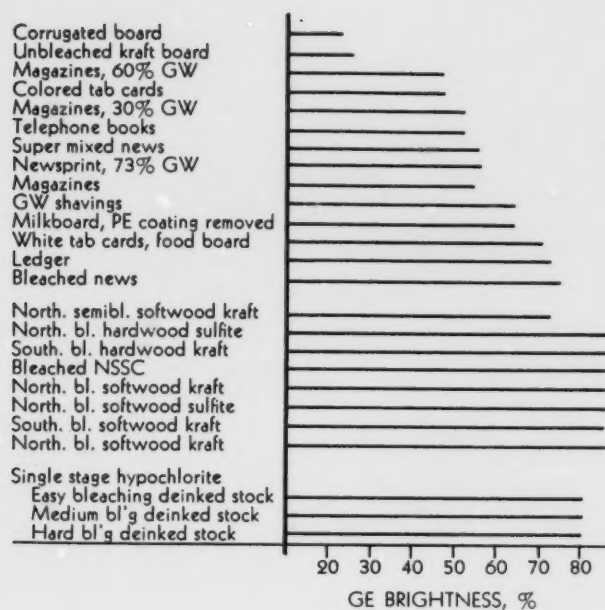


Source: Jurgen Kleinau. "Properties of Secondary Fibers".
TAPPI. July, 1966, pp. 90A-93A.



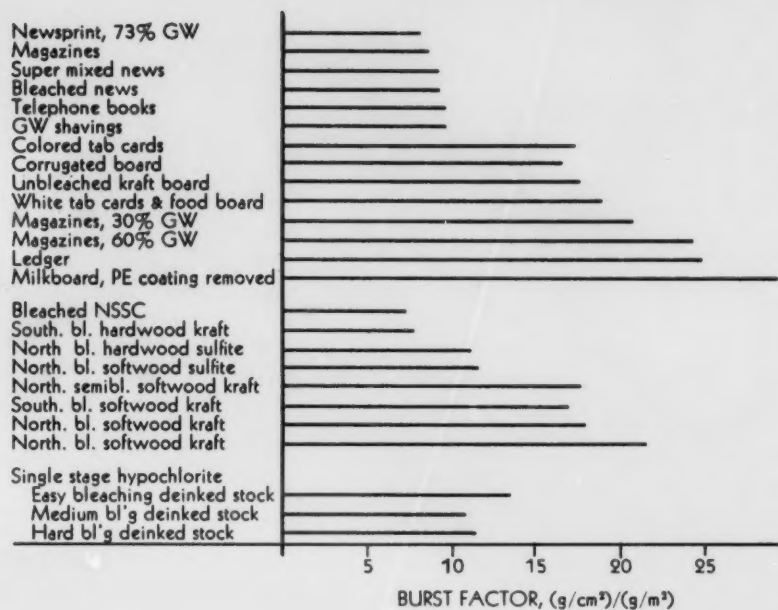
Appendix Figure VII.3 Tear Factor of Secondary Fibers. Source: Jurgen Kleinan. "Properties of Secondary Fibers". TAPPI. July, 1966, pp. 90A-93A.

Appendix Figure VII.4.
BRIGHTNESS OF SECONDARY FIBERS



Source: Jurgen Kleinau. "Properties of Secondary Fibers".
TAPPI. July, 1966, pp. 90A-93A.

Appendix Figure VII.5.
BURST FACTOR OF SECONDARY FIBERS



Source: Jurgen Kleinau. "Properties of Secondary Fibers".
TAPPI. July, 1966, pp. 90A-93A.

APPENDIX VIII

SUMMARY OF DIVERSIFICATION STRATEGIES

A firm's diversification strategy is defined as its commitment to diversity per se together with the strengths, skills or purposes that span this diversity, as evidenced by the way in which business activities are related one to another.

The primary measure of diversity is taken to be the specialization ratio, defined as the proportion of a firm's revenues that is attributable to its largest discrete product-market activity. A discrete business (or product-market activity) is one which is strategically independent of the firm's other businesses in the sense that basic changes in its nature and scope can be made without meeting constraints imposed by other of the firm's businesses and without materially affecting the operation and strategic direction of other of the firm's businesses.

Businesses are related to one another when a common skill, resource, market, or purpose applies to each. A firm's related ratio is defined as the proportion of its revenues that are attributable to the largest group of businesses that are related in some way to one another. Each member of this group need only be related to one other business in the group (linked relatedness), though it may be related to all and all may be directly related to one another (constrained relatedness).

Source: Rumelt, op. cit., pp. 52-57

The vertical ratio is defined as the proportion of a firm's revenues attributable to all of the by-products, intermediate products and final products of a vertically integrated sequence of manufacturing operations.

In any given year a firm's diversification strategy may be described as corresponding to one of the following categories:

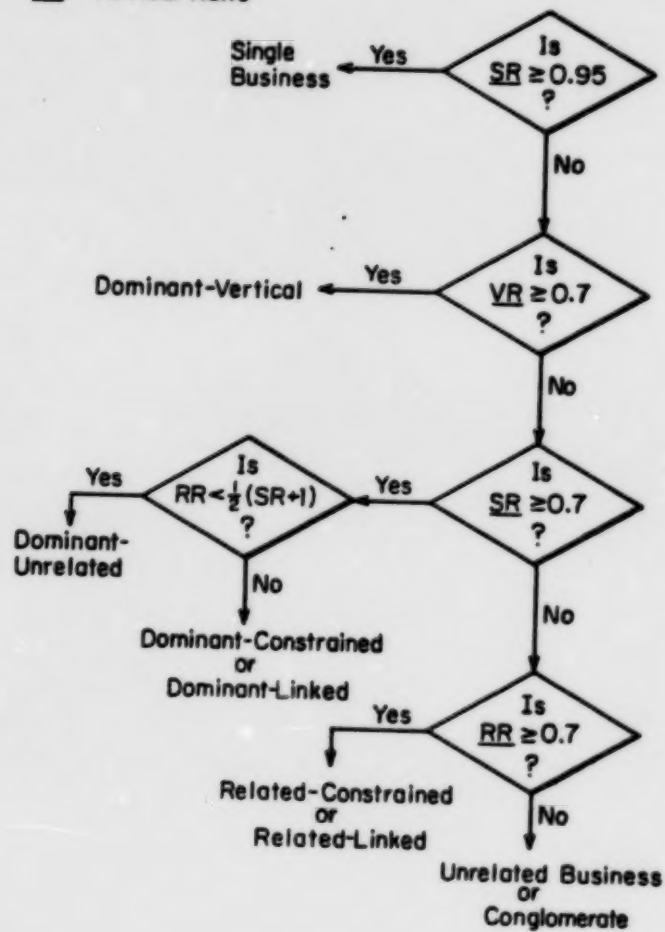
- I. Single business (abbreviated "S" or "SING") - firms that are basically committed to a single business. Among non-vertically integrated firms ($VR < 0.7$), Single business companies are those with specialization ratios of 0.95 or more. Among vertically integrated firms ($VR \geq 0.7$), those that have an end-product business that contributes 95% or more of total revenues are classified as Single business firms.
- II. Dominant business (abbreviated "D" or "DOM") - firms that have diversified to some extent but which still obtain the preponderance of their revenues from a single business. Among non-vertically integrated firms ($VR < 0.7$), those with specialization ratios greater than or equal to 0.7 but less than 0.95 are Dominant business firms. Among vertically integrated firms ($VR \geq 0.7$), those that do not qualify as Single business companies fall in the Dominant category.
 - A. Dominant Vertical (abbreviated "DV") - vertically integrated firms (having vertical ratios of 0.7 or more) which produce and sell a variety of end-products, no one of which contributes more than 95% of total revenues.
 - B. Dominant Constrained (abbreviated "DC") - non-vertical Dominant business firms that have diversified by building on some particular strength, skills, or resource associated with the original dominant activity. In such firms the preponderance of the diversified activities are all related one to another and to the dominant business.

- C. Dominant Linked (abbreviated "DL") - non-vertical Dominant business firms that have diversified by building on several different strengths, skills, or resources or by building on new strengths, skills or resources as they are acquired. In such firms the preponderance of the diversified activities are not directly related to the dominant business but each is somehow related to some other of the firm's activities.
 - D. Dominant Unrelated (abbreviated "DU") - non-vertical Dominant business firms in which the preponderance of the diversified activities are unrelated to the dominant business.
- III. Related business (abbreviated "R" or "REL") - non-vertically integrated firms which are diversified, having specialization ratios less than 0.7, and in which diversification has been primarily accomplished by relating new activities to old so that the related ratio is 0.7 or more.
- A. Related Constrained (abbreviated "RC") - Related business firms that have diversified chiefly by relating new businesses to a specific central skill or resource and in which, therefore, each business activity is related to almost all of the other business activities.
 - B. Related Linked (abbreviated "RL") - Related business firms which have diversified by relating new businesses to some strength or skill already possessed, but not always the same strength or skill. By diversifying in several directions and exploiting new skills as they are acquired, such firms have become active in widely disparate businesses.
- IV. Unrelated business (abbreviated "U" or UNRL") - non-vertical firms which have diversified chiefly without regard to relationships between new businesses and current activities. Such firms are defined by a related ratio of less than 0.7

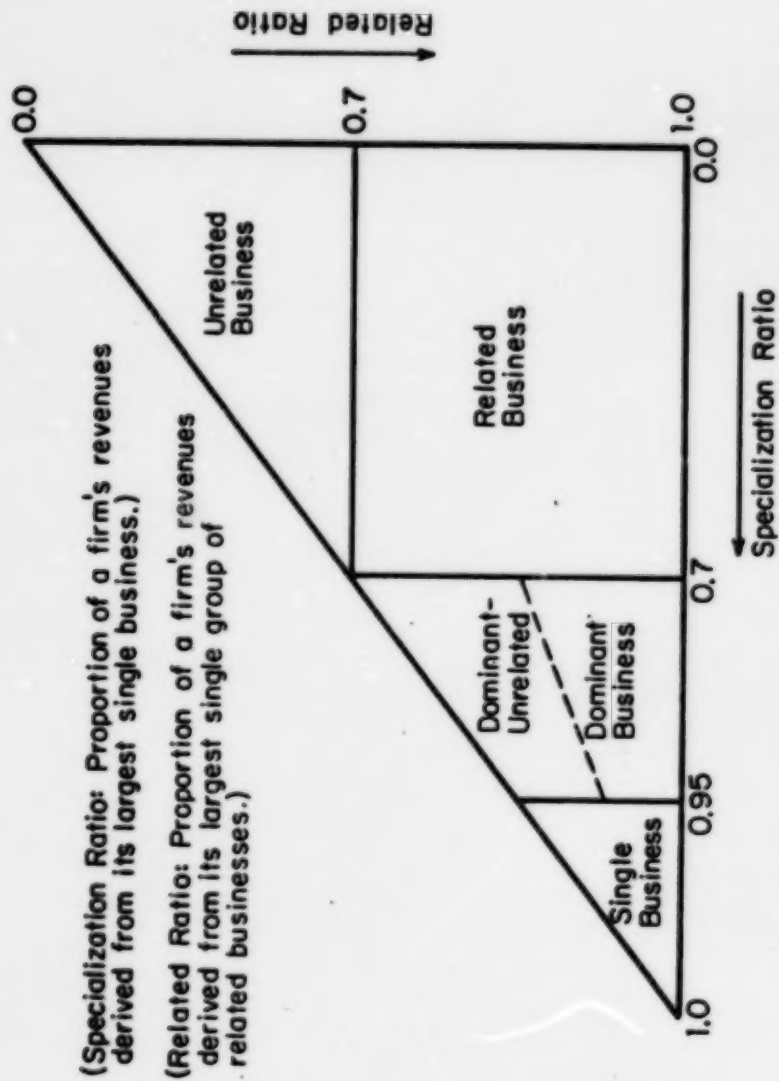
- A. Unrelated Passive (abbreviated "UP") - Unrelated business firms that do not qualify as Acquisitive Conglomerates (see definition below).
- B. Acquisitive Conglomerates (abbreviated "AC") - Unrelated business firms which have aggressive programs for the acquisition of new unrelated businesses. More specifically, such firms are defined as having, over the past five years, (1) had an average growth rate in earnings per share of at least 10% per year, (2) made at least five acquisitions, at least three of which took the firm into businesses unrelated to past activities, and (3) issued new equity shares whose total value (using market prices at the time of issue) was at least as great as the total amount of common dividends paid during the same period.

ASSIGNING DIVERSIFICATION CATEGORIES

$\underline{SR}$ = Specialization Ratio
 $\underline{RR}$ = Related Ratio
 $\underline{VR}$ = Vertical Ratio



STRATEGIC CLASSES DEFINED IN TERMS OF
THE SPECIALIZATION RATIO AND THE RELATED RATIO



APPENDIX 1A

PRIMARY METALS (SIC 33) AND PETROLEUM (SIC 29) MOVE TO DOMINANT VERTICAL BETWEEN 1949 AND 1969^a

Percent of Rumelt's Sample of
Fortune 500 companies in Each
Strategic Category by Year and
Industry

	Petroleum		Primary Metals	
	1949	1969	1949	1969
Single business	67	--	41	11
Dominant vertical	17	78	59	78
Dominant non-vertical	--	--	--	--
Related	16	22	--	11

^a Percentages calculated from Rumelt, *op. cit.*, pp. 180-181. Due to small size of random sample, these figures should be used as a trend guide only. Full definitions appear in Appendix VIII.

APPENDIX X

ESTIMATED PERCENTAGE OF FORTUNE 500 FIRMS IN EACH STRATEGIC CATEGORY^a

<i>Strategic Category</i>	<i>1949</i>	<i>1959</i>	<i>1969</i>
Major Classes			
Single Business	34.5	16.2	6.2
Dominant Business	35.4	37.3	29.2
Related Business	26.7	40.0	45.2
Unrelated Business	3.4	6.5	19.4
Minor Classes			
Single Business	34.5	16.2	6.2
Dominant-Vertical	15.7	14.8	15.6
Dominant-Constrained	18.0	16.0	7.1
Dominant-Linked	0.9	3.8	5.6
Dominant-Unrelated	0.9	2.6	0.9
Related-Constrained	18.8	29.1	21.6
Related-Linked	7.9	10.9	23.6
Unrelated-Passive	3.4	5.3	8.5
Acquisitive Conglomerate	0.0	1.2	10.9
Total number of firms used to derive the estimates	189	207	183

a Source: Rumelt, *op. cit.*, p. 90. Definitions appear in Appendix VIII.

APPENDIX XI.

MILL SIZE IN U.S. PAPER, PAPERBOARD AND WOOD PULP INDUSTRY^a

Thousands of Tons PAPERS & PAPERBOARD MILLS*				WOOD PULP MILLS*		
ANNUAL MILL CAPACITY	NUMBER OF MILLS	AGGREGATE ANNUAL CAPACITY	PERCENT OF TOTAL U.S. CAPACITY	NUMBER OF MILLS	AGGREGATE ANNUAL CAPACITY	PERCENT OF TOTAL U.S. CAPACITY
0 - 10	104	508	.8%	17	68	.1%
10 - 20	108	1,593	2.6	23	337	.7
20 - 30	82	2,046	3.4	18	444	.9
30 - 40	61	2,083	3.4	21	739	1.6
40 - 50	46	2,041	3.4	12	534	1.1
50 - 60	34	1,878	3.1	12	672	1.4
60 - 70	27	1,746	2.9	12	780	1.6
70 - 80	19	1,432	2.4	13	972	2.0
80 - 90	26	2,244	3.7	9	769	1.6
90 - 100	25	2,353	3.9	9	847	1.8
100 - 120	18	1,967	3.2	11	1,217	2.6
120 - 140	20	2,559	4.2	11	1,434	3.0
140 - 160	17	2,593	4.3	10	1,499	3.1
160 - 180	11	1,899	3.1	10	1,700	3.6
180 - 200	11	2,084	3.4	11	2,095	4.4
200 - 220	11	2,301	3.8	9	1,888	4.0
220 - 240	9	2,058	3.4	5	1,163	2.4
240 - 260	9	2,244	3.7	7	1,763	3.7
260 - 280	7	1,878	3.1	5	1,318	2.8
280 - 300	6	1,744	2.9	6	1,723	3.6
300 - 320	7	2,186	3.6	7	2,187	4.6
320 - 340	3	974	1.6	6	1,987	4.2
340 - 360	6	2,065	3.4	7	2,452	5.1
360 - 380	4	1,486	2.4	3	1,116	2.3
380 - 400	4	1,553	2.6	3	1,164	2.4
400 - 420	5	2,054	3.4	4	1,650	3.5
420 - 440	-	-	-	3	1,299	2.7
440 - 460	3	1,343	2.2	3	1,337	2.8
460 - 480	3	1,408	2.3	3	1,406	3.0
480 - 500	3	1,465	2.4	4	1,945	4.1
over 500	11	6,907	11.4	15	9,238	19.3
TOTAL U.S.	700	60,702	100.0%	289	47,743	100.0%

*Mill size in this section is measured as 1971 year end practical maximum capacity. Integrated Mills include those with active on-site wood pulp capacity, whether or not this capacity provides a significant portion of total fiber requirements.

^aSource: American Paper Institute, "Paper, Paperboard, Wood Pulp Capacity 1971-1974," 1972, p. 17.

APPENDIX XII

COST OF DOING BUSINESS RATIOS^a

	1962-63 %			1967-68 %				Converted Except Containers
	Paper & Allied Products	All Manuf.	All Manuf.	Paper & Allied Products	Pulp Mills	Paper & Board Mills	Paper- board Containers & Boxes	
Gross Margin	30.92	29.01	29.95	31.62	27.85	31.95	28.77	33.82
Compensation of Officers	1.24	1.26	1.16	1.06	.52	.45	2.19	1.83
Rent Paid on Business Properties	.76	.74	.85	.85	.52	.84	1.12	.70
Repairs	2.15	1.36	1.37	2.35	3.94	2.94	1.61	1.12
Bad Debts	.10	.15	.17	.13	.07	.13	.13	.12
Interest Paid	.82	.62	.97	1.24	3.02	1.47	.77	.69
Taxes Paid	2.22	2.93	3.06	2.37	2.82	2.48	2.12	2.19
Amortization, Depreciation Depletion	5.07	3.76	3.79	5.32	8.17	6.61	3.21	3.13
Advertising	.80		1.44	.82	.14	.98	.26	.94
Pension and Other Employee Benefit Plans	1.04	1.25	1.45	1.09	1.20	1.17	1.04	.89

^aSOURCE: Dun and Bradstreet, "Cost of Doing Business Ratios-Corporations", 1965, 1971. These figures represent a percentage of business receipts as reported by "a representative sample" of all Federal Income Tax returns filed in 1962-63, 1967-68.

Sales = 100%

APPENDIX XIII
INCREASING SIZE OF PLANT^a

Percentage of Wood Pulp Mills per Class in New York, 1955, 1965			
Wood pulp mill ton capacity for 24 hours	Percentage per class for 1955	Percentage per class for 1965	Percentage change from 1955 to 1965
Over 1,000	3.2	9.7	203
800-999	2.0	6.0	200
600-799	5.2	9.0	73
400-599	10.4	11.9	14
300-399	7.2	8.2	14
200-299	10.8	8.6	-20
100-199	24.4	21.6	-11
80-99	4.0	3.4	-15
60-79	12.4	6.3	-49
40-59	8.0	9.0	13
20-39	8.0	5.6	-30
Under 20	4.4	1.1	-75

^aSources: Lockwood's Directory of the Paper, and Allied Trades, Lockwood Trade Journal Co., Inc. (New York, 1955) pp. 227-53; (1965), p. 247-71. as done by Guthrie, op. cit. p. 186.

APPENDIX XIV.

FIXED ASSETS, DEPRECIATION, AND DEPLETION
FOR PAPER AND ALLIED PRODUCTS^a

Year	Fixed Assets as a % of total Assets	Depreciation & Amortization as a % of total com- piled receipts	Depletion as a % of total com- piled receipts
1950	41	2.0	.1
1951	41	2.0	.1
1952	43	2.4	.1
1953	44	2.6	.1
1954	45	3.0	.1
1955	44	3.2	.2
1956	46	3.2	.2
1957	50	3.6	.2
1958	51	4.0	.1
1959	61	3.8	.2
1960	64	4.0	.3
1961	64	4.2	.4
1962	64	4.7	.4
1963	63	4.8	.4
1964	64	4.8	.4
1965	63	4.6	.3
1966	65	4.5	.4
1967	65	4.7	.5
1968	67	4.5	.6
1969		4.3	.7

^a Source: Department of the Treasury, Internal Revenue Service, "Statistics of Income, Corporation Income Tax Returns Annual Issues"; from American Paper Institute, "A Capital and Income Survey," 1971, p. 8.

APPENDIX XV

LONG TERM DEBT/EQUITY IN PAPER AND ALLIED PRODUCTS ^a

YEAR	DEBT/EQUITY
1950	13.7
1951	15.8
1952	18.2
1953	17.6
1954	18.2
1955	18.6
1956	22.3
1957	22.5
1958	24.2
1958	23.7
1959	22.8
1960	23.3
1961	22.6
1962	25.1
1963	24.9
1964	23.7
1965	28.1
1965	30.0
1966	35.6
1967	41.5
1968	45.1
1969	41.9
1970	46.8
1971	49.7

^aSource: Percentages by author based on data in API, "Statistics of Paper 1972", p. 19 derived from Federal Trade Commission-Securities and Exchange Commission, Quarterly Financial Report for Manufacturing Corporations, 1950-1971.

APPENDIX XVI

FUNDS FOR R & D AS PERCENT OF NET SALES IN R & D-PERFORMING MANUFACTURING COMPANIES^a

	Paper & Allied Prod. (SIC 26)	All R&D Perf. Manufacturing
1957	.6	3.4
1958	.7	3.8
1959	.6	3.9
1960	.7	4.2
1961	.7	4.3
1962	.7	4.3
1963	.8	4.5
1964	.7	4.6
1965	.7	4.3
1966	.7	4.2
1967	.7	4.2
1968	.7	4.1

^aSource: National Science Foundation, "Science Resources Studies", Washington: National Science Foundation, December 10, 1971, p. 26.

APPENDIX XVII

PERCENT OF VALUE OF SHIPMENTS AND CAPITAL EXPENDITURES
ACCOUNTED FOR BY THE LARGEST COMPANIES -
PULP, PAPER, AND BOARD MILLS^a

	Percent of Shipments Value By				Percent of Capital Expenditures			
	4 Largest Cos.	8 Largest	20 Largest	50 Largest	4 Largest Cos.	8 Largest	20 Largest	50 Largest
Pulpmills								
1963	48	72	97	100	50	64	74	100
1958	48	68	94	100				
Paper mills, exc. bldg.	26	42	63	85	24	35	64	87
Paperboard mills	27	43	67	90	21	26	46	77

^a Source: U.S. Bureau of the Census, Concentration Ratios in Manufacturing Industry 1963.
For Senate Subcommittee on Antitrust and Monopoly. Vol. I, P. 16. 1966.

APPENDIX XVIII

PERCENT OF VALUE OF SHIPMENTS AND CAPITAL EXPENDITURES FOR BY THE LARGEST COMPANIES IN SELECTED SUB-INDUSTRIES, 1963^a

	Percent of Shipments Value By				Percent of Capital Expenditures			
	4 Largest Cos.	8 Largest	20 Largest	50 Largest	4 Largest Cos.	8 Largest	20 Largest	50 Largest
Tissue (2647)	62	76	90	99	39	63	80	92
Folding Boxes (2651)	21	37	55	69	35	47	61	75
Set-Up Boxes (2652)	12	19	30	48	12	20	24	43
Corrugated and Solid Fiber Boxes (2653)	20	36	63	79	18	29	59	76

^a Source: U.S. Bureau of the Census. Concentration Ratios in Manufacturing Industry 1963.
For Senate Subcommittee on Antitrust and Monopoly, 1966, Vol. I, pp. 17, 74, 75.

APPENDIX XIX

SELECTED ECONOMIC AND PAPER INDUSTRY STATISTICS, 1952-1972

	(1) Real GNP (billions)	(2) Paper Industry Demand/ Prod. (1) (000 tons)	(3) Capacity Additions (1) (000 tons)	(4) Paper Industry Operating Rate (2)	(5) Paper Industry Profits (1) (millions)	(6) % Change
1972 ^P	\$789.5	59,000	1,263	96.2%	\$883	+72.5%
1971	741.7	64,180	1,750	90.6	512	-28.8
1970	720.0	63,329	580	90.9	719	-27.2
1969	724.7	64,187	2,131	94.6	987	+11.0
1968	706.8	61,246	2,262	93.0	889	+11.7
1967	675.2	48,928	2,560	80.1	706	-12.6
1966	658.1	47,113	3,337	84.7	911	+4.8
1965	617.8	44,080	1,823	93.5	889	+15.3
1964	581.1	41,703	1,579	91.7	764	+18.9
1963	551.0	38,230	1,248	89.1	634	+1.0
1962	529.8	37,541	623	87.1	628	+7.7
1961	497.2	36,749	1,466	85.0	583	-0.7
1960	487.7	34,444	1,102	84.5	587	-5.2
1959	475.9	34,015	1,591	86.3	619	+34.8
1958	447.3	30,823	1,280	81.1	460	-11.7
1957	452.8	30,868	2,330	84.7	521	-20.7
1956	446.1	31,441	1,852	92.2	657	+8.7
1955	438.0	30,178	996	92.4	604	+26.1
1954	407.0	26,876	990(3)	84.8(3)	479	+6.4
1953	412.8	26,605	1,324(3)	87.2(3)	460	+3.0
1952	395.1	24,418	1,141(3)	83.4(3)	437	+3.1%
20-year Average (4)	+3.7%	+4.4%				

Source: Smith, Barney, "The Paper Industry - Another Decade of Disappointment?" New York, 5/18/73.

P - Preliminary

(1) American Paper Institute (API) data.

(2) Figured on average capacity that year. Computed from API data.

(3) Smith, Barney estimates based on API data.

(4) Computed by fitting log-linear, least squares trendlines to the figures in this 20-year period.

APPENDIX XX

CAPITAL EXPENDITURES FOR PLANT AND EQUIPMENT
IN PAPER AND ALLIED PRODUCTS^a

(\$Millions)

1947	407	1961	685
1948	N.A.	1962	750
1949	315	1963	709
1950	299	1964	901
1951	389	1965	1,185
1952	371	1966	1,422
1953	397	1967	1,585
1954	533	1968	1,238
1955	556	1969	1,420
1956	750	1970	1,313
1957	767		
1958	618		
1959	620		
1960	644		

^aSource: U.S. Bureau of the Census. Annual Survey
of Manufactures, various issues.

APPENDIX XXI
PULP AND PAPER INDUSTRY
ENVIRONMENTAL QUALITY PROTECTION CAPITAL EXPENDITURES - 1971

Million Dollars				
	Water	Air	Solid Waste Disposal from Manufacturing	Total
Through 1966	213	129	10	352
1967	44	31 (E)	1 (E)	76
1968	49	43 (E)	1 (E)	93
1969	74	52 (E)	2 (E)	128
1970	120	65 (E)	2 (E)	187
Through 1970	556 (1)	320	16	892
1971	134	66	2.5	203
Through 1971	690	386	18.5	1095
Planned 1972	274	132	8	414
Planned 1973	257	204	16	477
Planned 1974	256	162	15	433

Source: "A Survey of Pulp and Paper Industry Environmental Protection Expenditures and Accomplishments - 1971", National Council of the Paper Industry for Air and Stream Improvement, Inc. Special Report.

(1) Includes 56 million in undistributed internal process loss control expenditures made through 1969.

(E) Estimated distribution.

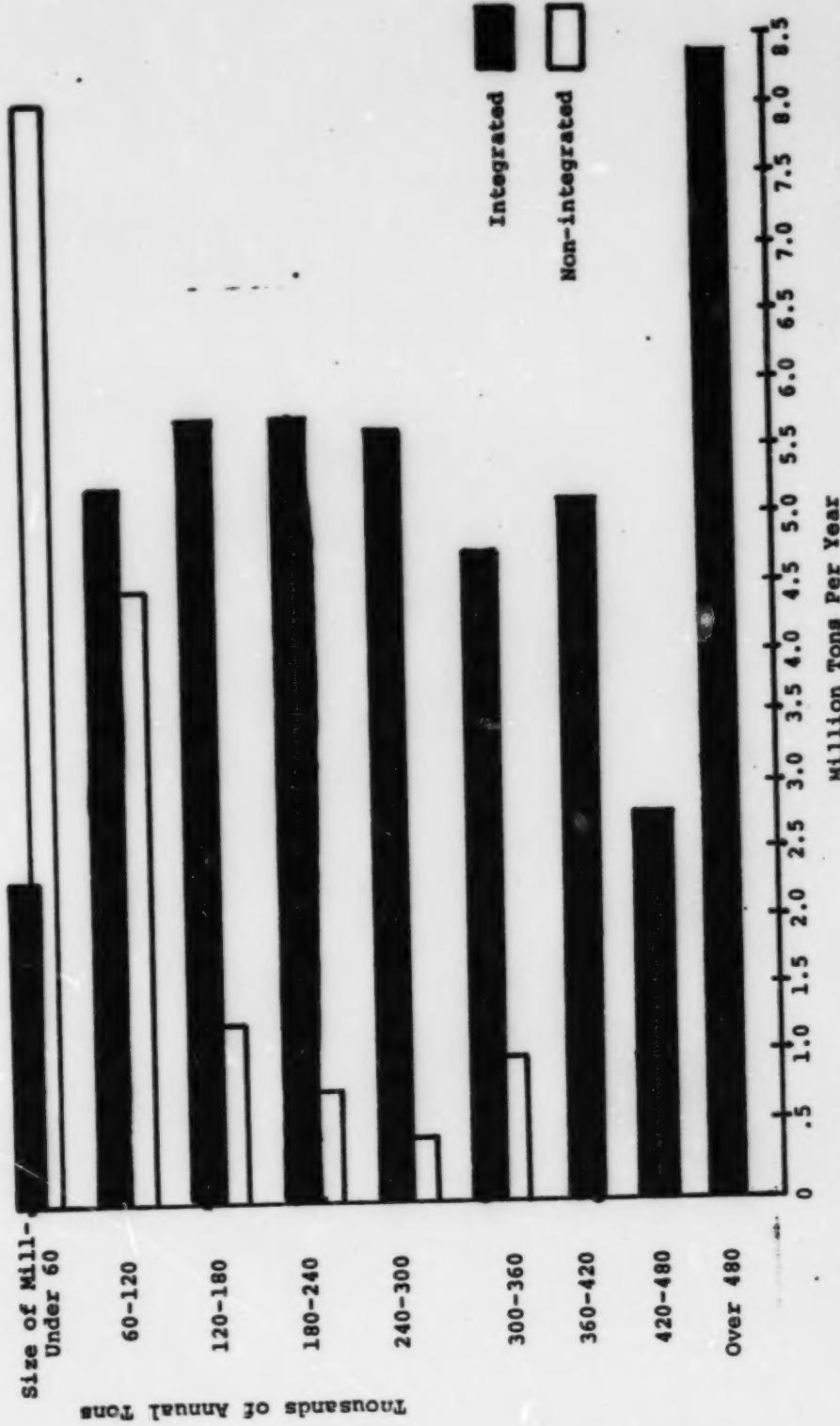
APPENDIX XXII.

PERCENT OF ESTABLISHMENTS AND PRODUCTION WORKERS FOR THE
LARGEST COMPANIES IN SELECTED SUB-INDUSTRIES, 1963

	4 largest co's.		8 largest		20 largest		50 largest	
	Establ.	Prod. Wkrs.	Est.	Prod. Wkrs.	Est.	Pr. Wk.	Est.	Pr. Wk.
Pulpmills	24	46	38	68	69	96	100	100
Papermills, exc. bldg.	14	23	23	39	36	62	52	84
Paperboard mills	12	25	17	38	37	62	62	85

Source: U.S. Bureau of the Census. Concentration Ratios
in Manufacturing Industry 1963. for Senate Sub-
committee on Antitrust and Monopoly, 1966, Vol.I.
p. 72.

APPENDIX XXIII
PAPER AND PAPERBOARD CAPACITY
IN INTEGRATED AND NON-INTEGRATED MILLS



Source: American Paper Institute, "Paper, Paperboard, Woodpulp Capacity, 1971-1974," p. 13.

APPENDIX XXIV

SELECTED RATIOS FOR INTEGRATED VS. NON-INTEGRATED FIRMS

	<u>ASSETS/SALES</u>		<u>PAT/SALES (%)</u>		<u>PAT/NET WORTH (%)</u>	
	Int.	Non-Int.	Int.	Non-Int.	Int.	Non-Int.
1957	1.10	.71	7.4	4.4	9.8	8.7
1958	1.12	.74	6.5	3.7	8.4	6.9
1959	1.04	.69	6.8	4.7	9.4	9.1
1960	1.03	.76	6.1	4.8	8.3	8.3
1961	1.00	.82	5.5	4.4	7.7	7.5
1962	1.00	.87	5.5	4.3	7.9	6.7
1963	1.00	.87	5.6	4.2	8.0	6.7
1964	.99	.88	6.0	4.4	8.8	7.2
1965	.97	.82	6.2	4.9	9.8	8.2
1966	.98	.76	6.5	5.2	10.7	10.4
1967	1.06	.78	5.4	3.8	8.5	9.2
1968	1.06	.78	5.3	4.1	8.9	7.5
1969	.99	.84	5.4	3.6	9.7	6.6
1970	1.03	.87	4.2	1.2	7.4	2.1
1971	1.01	.86	3.2	0.3	6.0	0.6

Source: American Paper Institute, "A Capital and Income Survey of the United States Paper Industry 1971", American Paper Institute, 1972, P. 11. PAT refers to profit after tax.

APPENDIX XXV

NEW SUPPLY^a OF WOOD PULP,
ALL GRADES
PERCENT CAPTIVE VS. MARKET^b

	<u>CAPTIVE</u>	<u>MARKET</u>
1940	76	24
1945	76	24
1950	80	20
1955	83	17
1960	87	13
1965	87	13
1970	89	11
1971	89	11

Source: Calculated from data on pages 57, 81 of American Paper Institute, Wood Pulp Statistics 36th Edition, 1972.
API's data source: Department of Commerce, Bureau of Census prior to 1963. Later, they used their own production figures and obtained import figures from Canadian Pulp & Paper Association, Imports of Captive Pulp.

^a New Supply = Production plus imports minus exports

^b Market Pulp = Pulp produced for sale

APPENDIX XXVI

NEW SUPPLY ^a OF WOOD PULP PERCENT CAPTIVE VS. MARKET ^b

	<u>CAPTIVE</u>		<u>MARKET</u>	
	<u>1955</u>	<u>1971</u>	<u>1955</u>	<u>1971</u>
Total Chemical	79	86	21	14
Unbleached Sulphate	95	98	5	2
Bleached & Semi- bleached Sulphate	76	80	24	20
Bleached Sulphite	67	76	33	24
Unbleached Sulphite	66	86	34	14

Source: Calculated percentages based on data contained on pages 28-34 of American Paper Institute, Wood Pulp Statistics 36th Edition, 1972.

^a

New Supply = Production minus exports plus imports.

^b

Market = pulp produced for sale.

APPENDIX XXVII

INTEGRATION TRENDS AT THE CONVERTING STAGE

Paperboard Inputs to Corrugated and Solid Fiber
Boxes (SIC 2653) - Market vs. Captive

Market as a Percent of Total

Paperboard Input	1963	1967
Tons	44.9	41.3
Dollars	45.0	42.3

Source: Author's calculations from Bureau of the Census data. 1967 Survey of Manufactures. Detailed statistics, p. 26C-22. Coverage ratio is 98 percent in 1967, General Summary, p. 33.

APPENDIX XXVIII

INTEGRATION TRENDS AT THE CONVERTING STAGE

Paperboard Inputs to Folding Boxes (SIC 2651)
Market vs. Captive

Market as a Percent of Total

Paperboard Input	<u>1963</u>	<u>1967</u>
Tons	45.2	41.9
Dollars	46.0	44.0

Source: Author's calculations based on Bureau of the Census data. 1967 Survey of Manufactures. Detailed statistics, p. 26C-22. Coverage ratio is 90 percent in 1967, General Summary, p. 33.

APPENDIX XXIX

Selected Statistics by Employment Size for:

Paper and Allied Products

Pulpmills

Papermills

Total

Integrated with a Pulp Mill

Not Integrated with a Pulp Mill

Paperboard Mills

Total

Integrated with a Pulp Mill

Not Integrated with a Pulp Mill

APPENDIX XXIX.1

SELECTED STATISTICS BY EMPLOYMENT SIZE, NUMBER
OF ESTABLISHMENTS, PAPER AND ALLIED PRODUCT, (SIC 26),
SELECTED STATISTICS BY EMPLOYMENT SIZE OF ESTABLISHMENT 1967

	Establishments		Value Added By Manufacture		Capital Expenditure		End of Year Inventories	
	No.	Percent	\$ Millions	Percent	\$ Millions	Percent	\$ Millions	Percent
All Establishments	5,890	100	9,756.3	100	1,585.3	100	2,262.8	100
1-4 employees	931	15.8	23.5	0.2	187.3	11.9	6.5	0.3
5-9 employees	460	7.8	39.1	0.4	6.2	0.4	8.2	0.4
10-19 employees	686	11.7	124.5	1.3	9.0	0.5	24.1	1.1
20-49 employees	1,223	20.8	445.8	4.6	89.1	5.6	94.6	4.2
50-99 employees	908	15.4	773.2	7.9	60.3	3.8	193.1	8.5
100-249 employees	1,090	18.5	2,256.2	23.1	356.6	22.5	572.9	25.3
250-499 employees	376	6.4	2,048.5	21.0	264.5	16.7	494.8	21.8
500-999 employees	138	2.3	1,853.5	19.0	258.0	16.3	453.0	20.0
1,000-2,499 employees	72	1.2	1,812.4	18.6	323.1	20.4	361.5	16.0
2,500 or more	6	0.1	373.3	3.9	29.8	1.9	54.0	2.4

Source: U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufacturers,
Summary Statistics, Volume I, p. 2-7. Percentages calculated by author.

Withheld to avoid disclosing figures for individual companies.

APPENDIX XXIX.2

PULPMILLS (S.I.C. 2611)

SELECTED STATISTICS BY EMPLOYMENT SIZE OF ESTABLISHMENT 1967

	Establishments		Value Added By Manufacture		Capital Expenditure		End of Year Inventories	
	No.	Percent	\$ Millions	Percent	\$ Millions	Percent	\$ Millions	Percent
All Establishments	61	100	333.7	100	121.8	100	96.7	100
1-4 employees	16	26.2	6.0	1.7	55.6	45.7	2.7	2.8
5-9 employees	-	-	-	-	-	-	-	-
10-19 employees	2	3.3	b	-	b	-	b	-
20-49 employees	8	13.1	b	-	b	-	b	-
50-99 employees	6	9.8	4.9	1.5	b	-	1.1	1.1
100-249 employees	7	11.5	24.7	7.4	b	-	8.4	8.7
250-499 employees	13	21.3	118.7	35.6	44.1	36.2	35.5	36.7
500-999 employees	6	9.8	104.6	31.3	10.1	8.3	35.8	37.0
1,000-2,499 employees	3	4.9	75.1	22.5	11.9	9.8	13.2	13.7
2,500 or more	-	-	-	-	-	-	-	-

Source: U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufacturers, Summary Statistics, Volume I, p. 2-7. Percentages calculated by author.

b Withheld to avoid disclosing figures for individual companies.

APPENDIX XXIX.3

PAPER MILLS EXCEPT BUILDING (S.I.C. 2621)

SELECTED STATISTICS BY EMPLOYMENT SIZE OF ESTABLISHMENT 1967

	Establishments		Value Added By Manufacture		Capital Expenditure		End of Year Inventories	
	No.	Percent	\$ Millions	Percent	\$ Millions	Percent	\$ Millions	Percent
All Establishments	354	100	2,356.3	100	581.3	100	560.3	100
1-4 employees	21	5.9	0.3	reg	26.7	4.6	0.1	reg
5-9 employees	5	1.4	0.5	reg	a	-	0.1	reg
10-19 employees	15	4.2	2.8	0.1	0.1	reg	0.8	0.1
20-49 employees	36	10.2	17.7	0.8	2.2	0.4	4.9	0.9
50-99 employees	37	10.5	46.6	2.0	2.8	0.5	10.9	1.9
100-249 employees	84	23.7	219.1	9.3	127.8	22.0	57.7	10.3
250-499 employees	66	18.6	401.2	17.0	113.1	19.5	109.6	19.6
500-999 employees	52	14.7	639.9	27.2	136.2	23.4	157.8	28.2
1,000-2,499 employees	35	9.9	1,027.8	43.6	172.2	29.6	218.2	38.9
2,500 or more	3	0.9	b	-	b	-	b	-

Source: U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufacturers, Summary Statistics, Volume I, p. 2-7. Percentages calculated by author.

Withheld to avoid disclosing figures for individual companies.

APPENDIX XXIX.4

PAPERMILLS INTEGRATED WITH A PULPMILL (S.I.C. 2621-12)

SELECTED STATISTICS BY EMPLOYMENT SIZE OF ESTABLISHMENT 1967

	Establishments		Value Added By Manufacture		Capital Expenditure		End of Year Inventories	
	No.	Percent	\$ Millions	Percent	\$ Millions	Percent	\$ Millions	Percent
All Establishments	107	100	1,610.3	100	417.8	100	346.9	100
1-4 employees	-	-	-	-	-	-	-	-
5-9 employees	-	-	-	-	-	-	-	-
10-19 employees	-	-	-	-	-	-	-	-
20-49 employees	1	0.9	34.8	2.1	157.1	37.6	9.3	2.7
50-99 employees	2	1.9	b	-	b	-	b	-
100-249 employees	9	8.4	b	-	b	-	b	-
250-499 employees	23	21.5	162.5	10.1	b	-	42.3	12.2
500-999 employees	39	36.5	491.0	30.5	111.0	26.6	112.1	32.3
1,000-2,499 employees	30	28.0	922.0	57.3	149.6	35.8	183.1	52.8
2,500 or more	3	2.8	b	-	b	-	b	-

Source: U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufacturers, Summary Statistics, Volume I, p. 2-7. Percentages calculated by author.

^bWithheld to avoid disclosing figures for individual companies.

APPENDIX XXIX.5

PAPERMILLS NOT INTEGRATED WITH A PULPMILL (S.I.C. 2621-14)

SELECTED STATISTICS BY EMPLOYMENT SIZE OF ESTABLISHMENT 1967

	Establishments		Value Added By Manufacture		Capital Expenditure		End of Year Inventories	
	No.	Percent	\$ Millions	Percent	\$ Millions	Percent	\$ Millions	Percent
All Establishments	247	100	746.1	100	163.5		213.4	100
1-4 employees	21	8.4	0.3	reg	26.7		0.1	0.1
5-9 employees	5	2.0	0.5	reg	a		0.1	0.1
10-19 employees	15	6.1	2.8	0.4	0.1		0.8	0.4
20-49 employees	35	14.2	248.5	33.3	57.1		64.3	30.1
50-99 employees	35	14.2	b	-	b		b	-
100-249 employees	75	30.4	b	-	b		b	-
250-499 employees	43	17.4	238.8	32.0	b		67.3	31.5
500-999 employees	13	5.3	149.2	20.0	25.2		45.7	21.4
1,000-2,499 employees	5	2.0	105.9	14.2	22.6		35.1	16.4
2,500 or more	-	-	-	-	-		-	-

Source: U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufacturers, Summary Statistics, Volume I, p. 2-7. Percentages calculated by author.

Withheld to avoid disclosing figures for individual companies.

APPENDIX XXIX.6

PAPERBOARD MILLS (S.I.C. 2631)

SELECTED STATISTICS BY EMPLOYMENT SIZE OF ESTABLISHMENT 1967

	Establishments		Value Added By Manufacture		Capital Expenditure		End of Year Inventories	
	No.	Percent	\$ Millions	Percent	\$ Millions	Percent	\$ Millions	Percent
All Establishments	283	100	1,508.8	100	398.6	100	191.9	100
1-4 employees	9	3.2	0.2	reg	114.9	28.8	0.1	reg
5-9 employees	2	0.7	b	-	b	-	b	-
10-19 employees	8	2.8	1.5	0.1	0.1	reg	0.3	0.2
20-49 employees	36	12.7	16.9	1.1	b	-	1.6	0.8
50-99 employees	61	21.6	74.1	5.0	6.7	1.7	9.5	5.0
100-249 employees	96	33.9	271.3	18.0	81.8	20.5	36.0	18.8
250-499 employees	40	14.1	355.5	23.6	26.5	6.6	45.2	23.5
500-999 employees	18	6.4	333.6	22.1	51.3	12.9	37.8	19.7
1,000-2,499 employees	12	4.2	455.0	30.1	117.4	29.5	61.4	32.0
2,500 or more	1	0.4	b	-	b	-	b	-

Source: U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufacturers, Summary Statistics, Volume I, p. 2-7. Percentages calculated by author.

Withheld to avoid disclosing figures for individual companies.

APPENDIX XXIX.7

PAPERBOARD MILLS INTEGRATED WITH A PULPMILL (S.I.C. 2631-12)

SELECTED STATISTICS BY EMPLOYMENT SIZE OF ESTABLISHMENT 1967

	Establishments		Value Added by Manufacture		Capital Expenditure		End of Year Inventories	
	No.	Percent	\$ Millions	Percent	\$ Millions	Percent	\$ Millions	Percent
All Establishments	74	100	1,075.1	100	283.3	100	131.3	100
1-4 employees	-	-	-	-	-	-	-	-
5-9 employees	-	-	-	-	-	-	-	-
10-19 employees	1	1.4	5.6	0.5	99.3	35.1	0.1	0.1
20-49 employees	1	1.4	b	-	b	-	b	-
50-99 employees	3	4.1	b	-	b	-	b	-
100-249 employees	21	28.3	87.9	8.2	b	-	9.0	6.8
250-499 employees	21	28.3	223.6	21.4	20.0	7.1	28.5	21.7
500-999 employees	14	18.9	297.2	27.6	46.6	16.4	32.3	24.6
1,000-2,499 employees	12	16.2	455.0	42.3	117.4	41.4	61.4	46.8
2,500 or more	1	1.4	b	-	b	-	b	-

Source: U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufacturers, Summary Statistics, Volume I, p. 2-7. Percentages calculated by author.

Withheld to avoid disclosing figures for individual companies.

APPENDIX XXIX.8

PAPERBOARD MILLS NOT INTEGRATED WITH A PULPMILL (S.I.C. 2631-14)

SELECTED STATISTICS BY EMPLOYMENT SIZE OF ESTABLISHMENT 1967

	Establishments		Value Added By Manufacture		Capital Expenditure		End of Year Inventories	
	No.	Percent	\$ Millions	Percent	\$ Millions	Percent	\$ Millions	Percent
All Establishments	209	100	433.7	100	115.3	100	60.6	100
1-4 employees	9	4.3	0.2	0.1	104.0	90.2	0.1	0.1
5-9 employees	2	1.0	b	-	b	-	b	-
10-19 employees	7	3.3	87.8	20.2	b	-	11.2	18.6
20-49 employees	35	16.7	b	-	b	-	b	-
50-99 employees	58	27.8	b	-	b	-	b	-
100-249 employees	75	35.9	183.4	42.3	b	-	27.0	44.6
250-499 employees	19	9.1	125.9	29.0	6.6	5.7	16.7	27.6
500-999 employees	4	1.9	36.4	8.4	4.7	4.1	5.5	9.1
1,000-2,499 employees	-	-	-	-	-	-	-	-
2,500 or more	-	-	-	-	-	-	-	-

Source: U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufacturers, Summary Statistics, Volume I, p. 2-7. Percentages calculated by author.

^b Withheld to avoid disclosing figures for individual companies.

APPENDIX XXX

SUMMARY OF ORGANIZATIONAL STRUCTURES

Functional: An organization in which the major sub-units are defined in terms of business functions of stages in the manufacturing process. Responsibility for coordination and product-market performance rests with the chief executive, his staff and committees. Vertically integrated firms fall in this class despite the common practice of referring to their process-linked sub-units as divisions.

Functional With Subsidiaries: An organization that is basically functional but which also has one or more separate product divisions (not necessarily true subsidiaries) which report to top management or, in some instances, to one of the functional managers. The distinguishing characteristic is that the general managers of the product divisions are organizationally on the same level or below the functional managers.

Product Division: An organization that consists of a central office and a group of operative divisions, each having the responsibility and resources needed to engineer, produce and market a product or set of products. In some instances the product divisions are clustered into groups and a third line of general management is placed between the division and headquarters. At some point below the division level, the organization reverts to a functional or geographic form.

Geographic Divisions: An organization that consists of a headquarters office and a group of operating divisions, each having the responsibility and resources needed to engineer, produce and market a product or set of products in a different geographic area. The areas may be portions of the United States or multi-national. At some point below the division level the form of organization reverts to a functional or product form.

Holding Company: An association of firms (or divisions) commonly owned by a parent corporation. Each firm is virtually autonomous and formal organization above the level of the individual firm is virtually non-existent.

Source: Rumelt, op. cit., pp. 68-69.

APPENDIX XXXI

STRATEGY AND STRUCTURE AMONG THE TOP 500, 1949 - 1969

Strategic Class	Percentage in Each Structural Class				
	Functional	Functional with Sub-sidiaries	Product Division	Geo-graphic Division	Holding Company
1949					
Single	90.7	4.0	2.7	1.3	1.3
Dominant	56.8	23.2	17.1	0	2.9
DV	61.9	25.3	12.9	0	0
DC	53.1	18.8	22.4	0	5.6
DL + DU	50.0	50.0	0	0	0
Related	42.2	14.2	40.3	0	3.3
RC	49.0	17.8	30.9	0	2.3
RL	26.2	5.5	62.7	0	5.5
Unrelated	0	0	61.2	0	38.8
UP	0	0	61.2	0	38.8
AC	-	-	-	-	-
1969					
Single	62.3	14.2	14.2	9.3	0
Dominant	20.7	17.5	60.3	1.5	0
DV	32.2	22.6	45.2	0	0
DC	14.2	6.2	73.5	6.2	0
DL + DU	0	17.8	82.2	0	0
Related	2.9	6.6	89.5	1.0	0
RC	4.1	9.7	86.3	0	0
RL	1.9	3.7	92.5	1.9	0
Unrelated	0	2.3	85.3	0	12.4
UP	0	5.2	94.8	0	0
AC	0	0	77.8	0	22.2

Source: Rumelt, *op. cit.*, p. 122. See Appendices VIII and XXX for definitions.

APPENDIX XXXII

ACTUAL AND PROJECTED PRODUCTION OF PAPER AND PAPERBOARD 1961-1971

Code	Type or Grade of Paper	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	All grades total	35,749	37,541	39,230	41,703	44,080	47,113	46,926	50,703	54,058	53,329	55,092
	Paper Total	15,823	16,537	17,300	18,152	19,187	20,653	20,944	22,091	23,505	23,409	23,838
	Printing, writing & related paper, total	9,212 ¹	9,694 ¹	10,162 ¹	10,681 ¹	11,322 ¹	12,446 ¹	12,632	13,396	14,481	14,369	14,505
	Tissue and other machine creped paper, total	2,312	2,411	2,573	2,754	2,987	3,099	3,213	3,420	3,499	3,595	3,876
	Sanitary Paper Total	2,078	2,179	2,340	2,516	2,651	2,847	2,955	3,160	3,265	3,379	3,657
2621010	Toilet Tissue	936	985	1,055	1,107	1,121	1,170	1,158	1,231	1,222	1,300	1,380
2621030	Facial Tissue o/t											
2621050	toweling, napkin & towel	262	262	279	328	327	338	341	351	385	375	358
2621060	Napkin	247	249	263	269	287	333	354	376	375	374	388
	Toweling excluding wiper stock, but including facial tissue stock for towels	563	608	666	731	818	900	981	1,059	1,089	1,120	1,207
2621070	Other sanitary stock, incl. sanitary napkin stock mudding and wiper stock	70	75	79	81	98	107	121	143	195	210	324
2621080	Tissue paper, except sanitary and thin	234	232	233	227	236	252	258	260	234	215	214
	PAPER BOARD TOTAL	16,535	17,484	18,239	19,605	20,834	22,574	22,085	24,267	26,022	25,465	26,120
	Solid Wood Pulp, Furnish Paper Board Total	9,533	10,244	10,754	11,821	12,744	14,269	15,012	16,820	18,678	18,496	19,158
2631110	Unbleached liner board	5,536	6,008	6,329	7,018	7,657	8,436	8,563	9,528	10,951	10,994	11,311
2631130	Corrugating medium	71	0	0	0	67	71	39	0	0	0	0
2631150	Folding carton type paperboard	46 ²	63 ²	53 ²	103 ²	91 ²	85 ²	201	244	0	0	0
	Bleached packaging and industrial converting paperboard (85 percent or more bleached fiber) total	1,845 ¹	2,013 ¹	2,095 ¹	2,222 ¹	2,277 ¹	2,810 ¹	3,110	3,467	3,450	3,405	3,501
2631210	Folding carton type paperboard	556	608	675	671	659	892	1,206	1,406	1,435	1,398	1,433
2631270	Linerboard	77	86	96	102	86	309	115	129	171	132	130
	Semi chemical paperboard, total	2,035	2,160	2,277	2,478	2,653	2,867	2,901	3,335	3,595	3,460	3,717
2631310	Corrugating medium											
2631330	Other semichemical paperboard											
	Combination furnish paperboard, total	7,903	7,241	7,483	7,784	8,090	8,305	7,073	7,447	7,344	6,969	6,963
	Combination paperboard-shipping, container-board, total	1,533	1,671	1,723	1,817	1,868	2,011	1,766	1,756	1,580	1,486	1,191
2631410	Linerboard	741	676	649	732	769	762	677	587	380	316	259
2631430	Corrugating medium	558	706	745	761	777	891	815	864	888	884	879
2631500	Combination paperboard-bending	3,013 ³	3,074 ³	3,127 ³	3,200 ³	3,374 ³	3,539 ³	2,762 ⁴	2,874	2,875	2,729	2,637
2631600	Combination paperboard-nonbending	1,018	968	982	1,014	1,042	1,060	1,069	1,104	1,139	1,061	998
	CONSTRUCTION PAPER AND BOARD, TOTAL	3,236	3,374	3,551	3,798	3,915	3,738	3,753	4,190	4,384	4,316	4,995

Unit = thousands of short tons

Notes: 1 Does not include tube, can, drum and other stock.
 2 Includes bleached lined kraft-backed solid pulp boxboard.
 3 Includes some solid wood pulp folding and other boxboard.
 4 As reported. Later data show these totals include tonnages from other grades.

D = Withheld by Census to avoid disclosing figures for individual companies.

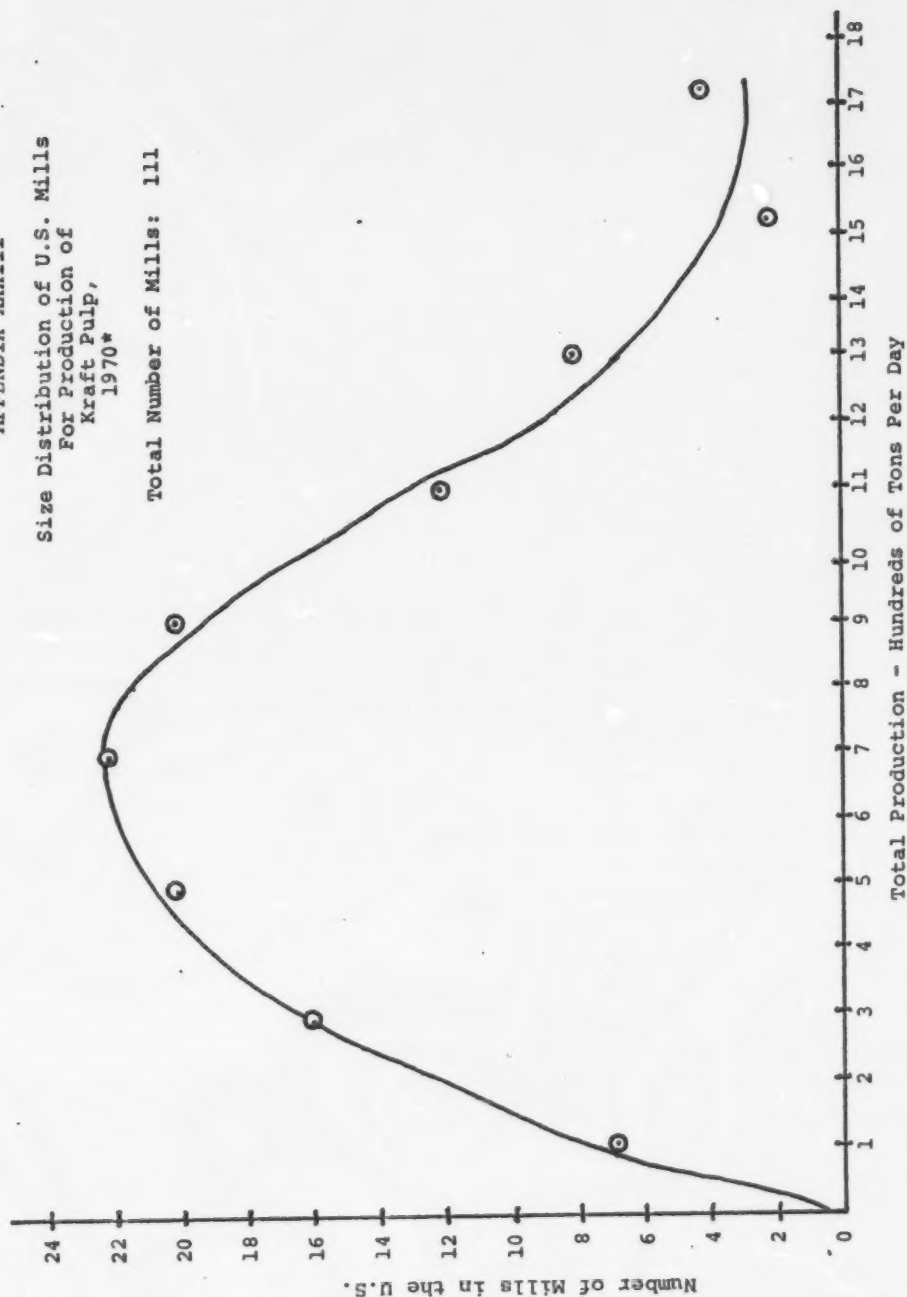
P = Projected

Source: 1961-1967, American Paper Institute: *The Statistics of Paper*, 1972, Table IV.
 1968-1971, U.S. Dept. of Commerce, Bureau of the Census, Current Industrial Reports.

APPENDIX XXXIII

Size Distribution of U.S. Mills
For Production of
Kraft Pulp,
1970*

Total Number of Mills: 111

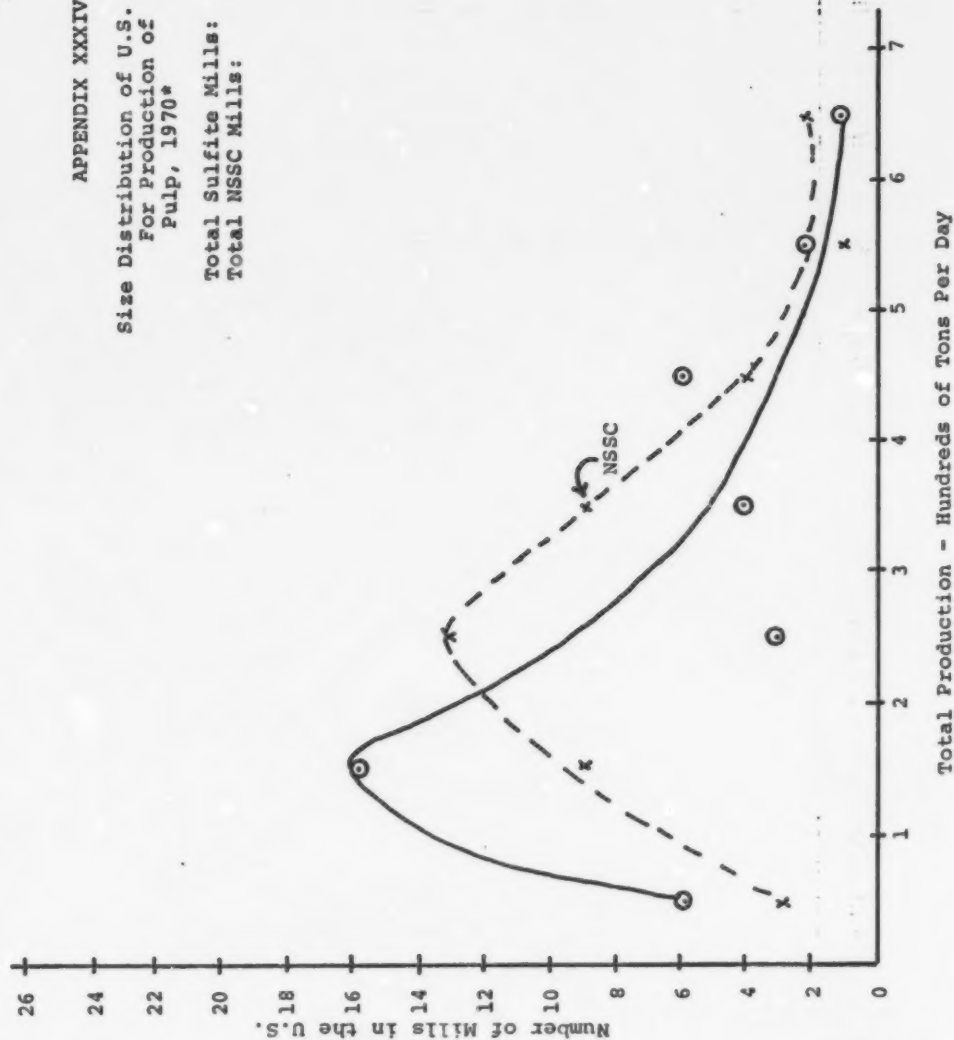


Source: Arthur D. Little, Inc. "Economic Impact of Anticipated Paper Industry
Pollution - Abatement Costs, Part II: Industry Structure and Business
Outlook." Report to The Council on Environmental Quality, p. 27, 1971.

APPENDIX XXXIV

Size Distribution of U.S. Mills
For Production of
Pulp, 1970*

Total Sulfite Mills: 37
Total NSSC Mills: 41

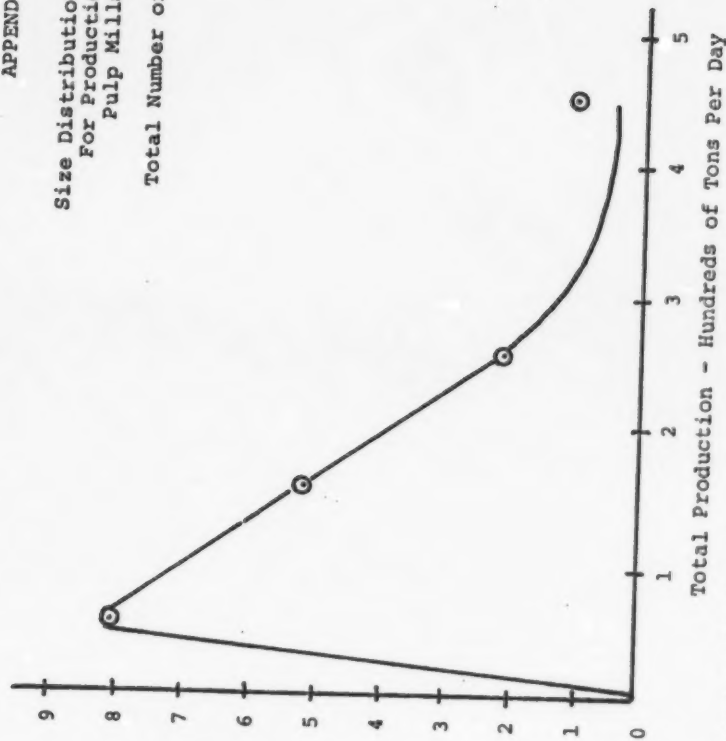


*Source: Arthur D. Little, Inc. "Economic Impact of Anticipated Paper Industry Pollution - Abatement Costs, Part II: Industry Structure and Business Outlook." Report to The Council on Environmental Quality, p. 28, 1971.

APPENDIX XXXV

Size Distribution of U.S. Mills
For Production of De-Ink
Pulp Mills, 1970*

Total Number of Mills: 16

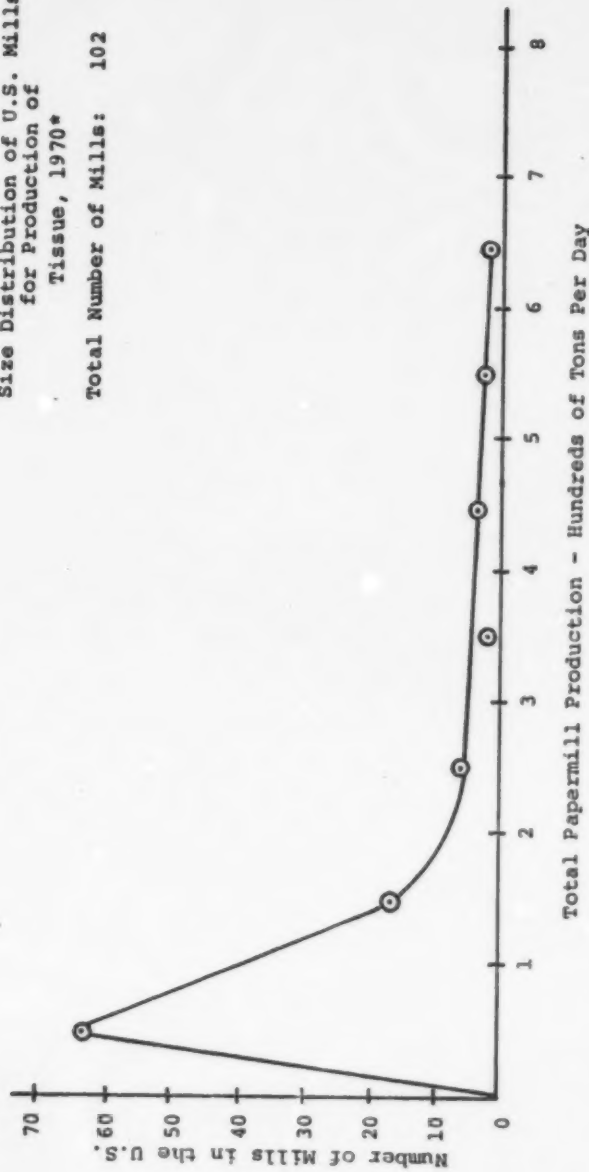


*Source: Arthur D. Little, Inc. "Economic Impact of Anticipated Paper Industry Pollution - Abatement Costs, Part II: Industry Structure and Business Outlook." Report to The Council on Environmental Quality, p. 29, 1971.

APPENDIX XXXVI

Size Distribution of U.S. Mills
for Production of
Tissue, 1970*

Total Number of Mills: 102

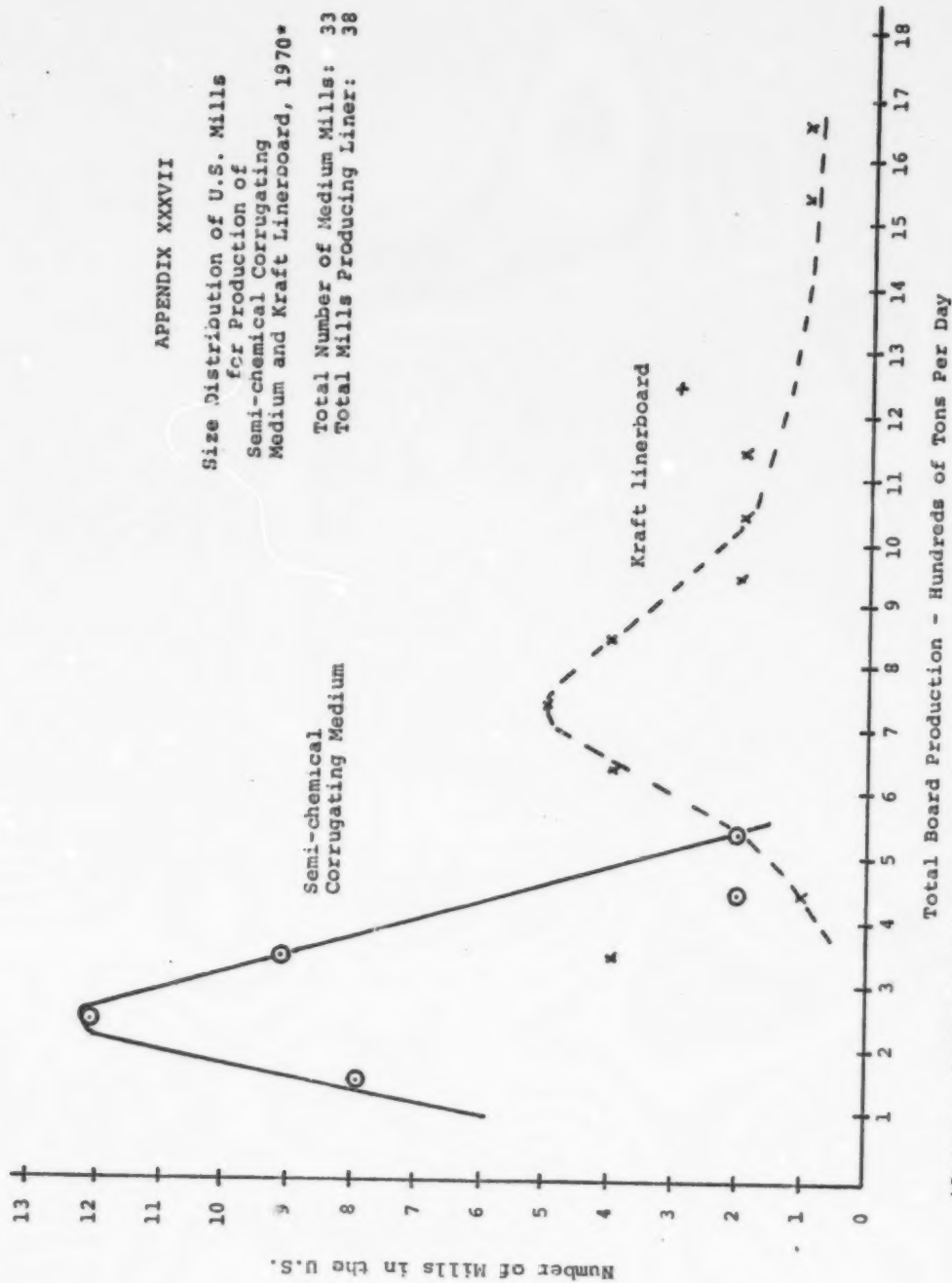


*Source: Arthur D. Little, Inc. "Economic Impact of Anticipated Paper Industry Pollution - Abatement Costs, Part II: Industry Structure and Business Outlook." Report to The Council on Environmental Quality, p. 21, 1971.

APPENDIX XXXVII

Size Distribution of U.S. Mills
for Production of
Semi-chemical Corrugating
Medium and Kraft Linerboard, 1970*

Total Number of Medium Mills: 33
Total Mills Producing Liner: 38

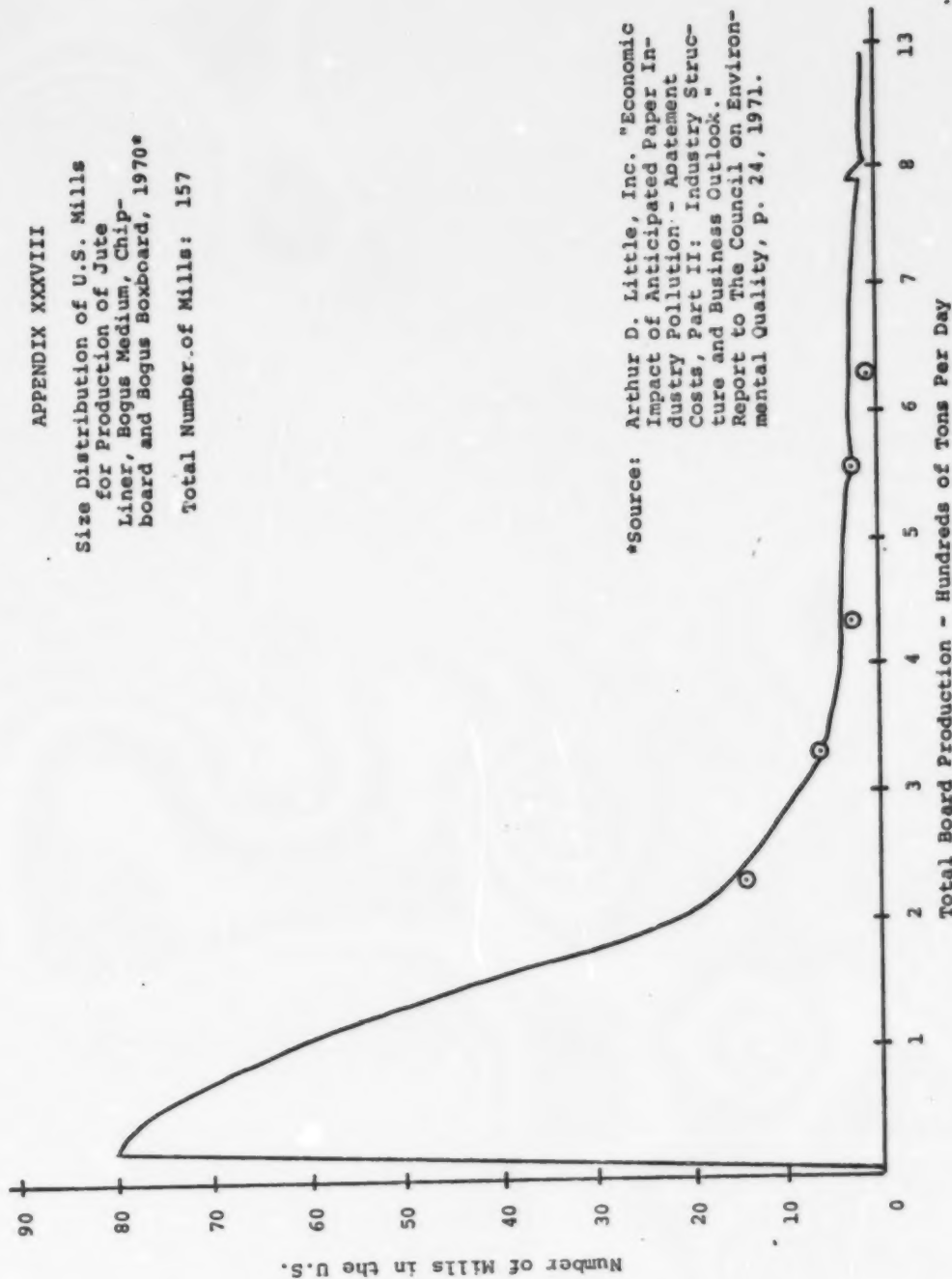


*Source: Arthur D. Little, Inc. "Economic Impact of Anticipated Paper Industry Pollution - Abatement Costs, Part II: Industry Structure and Business Outlook." Report to The Council on Environmental Quality, p. 24, 1971.

APPENDIX XXXVIII

Size Distribution of U.S. Mills
for Production of Jute
Liner, Bogus Medium, Chip-
board and Bogus Boxboard, 1970*

Total Number of Mills: 157



*Source: Arthur D. Little, Inc. "Economic
Impact of Anticipated Paper In-
dustry Pollution - Abatement
Costs, Part II: Industry Struc-
ture and Business Outlook."
Report to The Council on Environ-
mental Quality, p. 24, 1971.

APPENDIX XXXIX

TISSUE (SIC 2647) OPERATING RATIOS

	Year	
	<u>1963</u>	<u>1967</u>
Production Workers as		
Percent of total employment	80	83
Cost of Materials per Dollar of		
Shipment (\$)	.63	.59
Cost of Materials and Payroll per		
Dollar of Shipment (\$)	.74	.71
Value Added per Production Worker		
Man-hour (\$)	11.43	14.36

Source: U.S. Bureau of the Census. 1967 Census of
Manufactures. Detailed Statistics, P. 26B-10.

APPENDIX XXXX

PERCENT OF VALUE OF SHIPMENTS OF EACH CLASS OF
SELECTED PAPER OR BOARD MILL OUTPUT ACCOUNTED
FOR BY THE LARGEST COMPANIES

	Percent of Value of Shipments by			
	4 Largest	8 Largest	20 Largest	50 Largest
Tissue Stock				
1963	56	72	88	99
1958	57	69	83	94
1954	54	64	80	NA
Container Board-Kraft (26311-26312, exc. sp. fd. bd.)				
1963	32	54	82	99+
1958	37	57	84	99
1954	42	59	83	NA
Combination Paperboard: Shipping Containerboard (26314) - old designation as folding boxboard stock				
1963	31	49	75	98
1958	34	50	75	97
Combination Bending and Non-Bending Paperboard (26315, 26316) - once called set-up boxboard				
1963	37	52	79	NA
1958	28	48	78	NA

Source: U.S. Bureau of the Census. Concentration Ratios in
Manufacturing Industry 1963. For Senate Subcommittee
on Antitrust and Monopoly. Vol. I. pp. 168-169. 1966.

APPENDIX XXXXI

PERCENT OF VALUE OF SHIPMENTS OF EACH CLASS OF CONVERTED PAPER AND BOARD PRODUCTS ACCOUNTED FOR BY THE LARGEST COMPANIES

	4 Largest	8 Largest	20 Largest	50 Largest
Tissue (2647)				
1963	59	74	90	98
Sanitary Napkins & Tampons (26471)				
1963	D	D		
1958	97	D	100	-
1954	98	100	-	-
Sanitary Paper Products (26472)				
1963	61	77	90	98
1958	61	75	90	98
1954	37	57	83	NA
Folding Boxes (2651)				
1963	21	34	51	67
1958	21	31	49	66
1954	19	31	50	NA
Corrugated and Solid Fiber Boxes (2653)				
1963	19	36	62	79
1958	21	36	55	73

Source: U.S. Bureau of the Census. Concentration Ratios in
Manufacturing Industry 1963. For Senate Subcommittee
on Antitrust and Monopoly. Vol. I. pp. 172-173. 1966.

APPENDIX XXXXII

PERCENT OF ESTABLISHMENTS AND PRODUCTION WORKERS ACCOUNTED FOR BY THE LARGEST COMPANIES IN SELECTED SUB-INDUSTRIES, 1963

	4 Largest		8 Largest		20 Largest		50 Largest	
	Est. Prod.W.		Est. Pr.W.		Est. Pr.W.		Est. Pr.W.	
Tissue (2647)	18	57	24	68	38	84	63	97
Folding Boxes (2651)	4	17	8	31	14	46	23	61
Set-up Boxes (2652)	3	10	5	14	9	23	15	41
Corrugated & Solid Fiber Boxes (2653)	11	18	19	33	35	60	46	76

Source: U.S. Bureau of the Census. Concentration Ratios
in Manufacturing Industry 1963, for Senate
Subcommittee on Antitrust and Monopoly.
Vol. I. Pp. 74-75, 1966.

APPENDIX XXXIII

TISSUE PAPER PRODUCTS (S.I.C. 2647)

Table V.1.2. SELECTED STATISTICS BY EMPLOYMENT SIZE OF ESTABLISHMENT 1967

	Establishments		Value Added by Manufacture		Capital Expenditure		End of Year Inventories	
	No.	Percent	\$ Millions	Percent	\$ Millions	Percent	\$ Millions	Percent
All Establishments	125	100	119.2	100	58.5	100	78.9	100
1-4 employees	20	16.0	0.1	0.1	32.6	55.7	0.1	0.1
5-9 employees	5	4.0	0.1	0.1	b	-	0.1	0.1
10-19 employees	14	11.2	0.7	0.6	b	-	0.7	0.9
20-49 employees	20	16.0	2.9	2.5	b	-	2.1	2.7
50-99 employees	17	13.6	5.0	4.2	b	-	5.9	7.5
100-249 employees	21	16.8	15.6	13.1	b	-	13.3	16.9
250-499 employees	15	12.0	31.3	26.3	5.1	8.7	21.8	27.6
500-999 employees	9	7.2	34.7	29.1	13.3	22.7	21.4	26.7
1,000-2,499 employees	4	3.2	28.6	24.0	7.6	12.9	13.8	17.5
2,500 or more	-	-	-	-	-	-	-	-

Source: U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufacturers, Summary Statistics, Volume I, p. 2-7. Percentages calculated by author.

Withheld to avoid disclosing figures for individual companies.

APPENDIX XXXXIV

INPUTS TO TISSUE STOCK PRODUCTION

	Percent of Fibrous Inputs		
	1954 ¹	1963 ²	1970 ³
Wood, Pulp, total	85.0	84.0	
Sulfite, total	45.6	38.1	
Bleached	32.1	35.5	
Unbleached	13.6	2.6	
Sulfate, total	25.6	31.7	
Bleached softwood	18.7	16.8	
Bleached hardwood	1.5	11.4	
Semi bleached	0.6	.8	
Unbleached	5.0	2.7	
Groundwood	12.4	7.4	
Other Wood Pulp	1.0	1.8	
Waste Paper	14.7	15.9	27
Other Waste Material	.2	—	
Fibrous Inputs as percent of Production	1.06	1.129	

1. Source: Percentages calculated by author based on U.S. Bureau of the Census. Census of Manufactures 1954. p. 26A-28.
2. Source: Percentages by author based on data in API. Wood Pulp Statistics, 36th edition, P. 61 from 1963 Census of Manufacturers.
3. Midwest Research Institute, op. cit., p. 116 citing "Census" data.

APPENDIX XXXXV

DERIVATION OF COMBINATION LINERBOARD NUMBERS

- 1) Product: 42 lb/1000 sq. ft. combination linerboard
- 2) Size: 450 tpd, 352 dpy, 158,400 tpy
- 3) Investment: \$43,400,000 + \$1 MM land

Distributed as follows: (see Table XXXXV.1)

Year	(-2)	(-1)	(0)
\$ (000)	2,400	35,300	5,700
excluding land %	5.7	81.1	13.2
Plant	2,200	10,700	1,800
Equipment	200	24,600	3,900

Source: Imperial

4) Sales

\$2.69/MSF = 128.10/ton, freight out \$8/ton (midpoint of sample firm estimates assuming city location).

Net sales @ 120.10/ton

1st year = \$16,360,502 (86% Normal tons = 136,224)

Normal year = 19,023,840

5) Fiber Input (percentages and yields from Imperial)

(158,400) x (.72 base fraction) (1.12 yield factor) =
127,734 tons base stock

(158,400) x (.28 top liner fraction) (1.08 yield factor) =
47,900 tons top liner stock

Total Tons - 175,634

Base Stock Cost:

96.6% old corrugated @ \$37 (NYC/Chicago price, Paper Trade Journal, 8/20/73 p. 28)

3.4% #1 mixed @ \$10 (NYC/Chicago price, Paper Trade Journal, 8/20/73 p. 28)

Freight in assumed to be \$5 for near city location (see Jack Milgram of Arthur D. Little, Can Federal Procurement Practices Be Used to Reduce Solid Wastes, Final Report to Office of Research and Development, U.S.E.P.A., Washington, D.C. under Contract No. CPE 68-03-0047, October, 1973, p. 96a., and Midwest Research Institute, op. cit.

Total Base Stock Cost = (127,734) [(1.966) (\$42) + (.03) (\$15)] = \$5,239,904 (41.022/ton)

Table XXXXV.1: 450 tpd COMBINATION LINERBOARD MILL

PLANT AND EQUIPMENT CAPITAL COSTS¹

<u>Capital Item (P or E)²</u>	<u>Cost (\$)</u>	<u>Year of Expenditure³</u>
Site & Preparation (P)	496,000	(-2)
Fire Prot. (P)	243,600	(0)
Wells (P)	170,700	(-1)
Raw Material Storage (P)	273,500	(-1)
Pulp Preparation (E)	5,009,870	(-1)
Stock Preparation (E)	2,379,520	(0)
Paper Machine (3-off) (E)	15,138,130	(-1)
Product Warehouse & Shipping (P)	949,450	(0)
Coal Plant (P & E)	6,885,690	(-1)
Electric Primary Distrib. (P & E)	259,445	(-1)
Utility (P)	1,065,760	(-1)
Effluent System (Primary & Second) (P & E)	1,238,680	(-1)
Additive System (for inputting chemicals) (E)	945,235	(0)
Shops and Stores (P)	634,500	(0)
Total Direct	35,690,020	
Contractor (P)	4,508,464	(-1)
Engineering (P)	1,705,000	(-2)
Spare Parts (E)	567,500	(0)
Sales Tax (4-1/2%) (E & P)	179,865	(-1)
Construct Supervisor (P)	379,500	(-1)
Freight for Machines (E)	155,000	(-1)
Start-Up (E)	252,850	(-2)
Service Engineer & Erectors (E)	81,000	
Total	43,519,000	

¹Imperial engineering study.²P or E designation by Resource Planning Associates Engineer.³Year (1st operating year = (1)) estimated by Resource Planning Associates Engineer.

APPENDIX XXXXV (continued)

Top Liner Cost:

100% New Corr. Cuttings (Semi-chem. medium) @ \$62

Input Freight Assumed = \$5.00/ton, as before

Total Top Liner Cost: $(47,900) \cdot (\$67) = \$3,209,300$

Fiber Cost, Normal Year 8,449,204

Fiber Cost, 1st year 7,266,315

6) Conversion Costs (from Imperial)

Variable

Chemicals: Size @ 21¢/ton paper

Alum @ 30¢/ton

Starch @ 3.63/ton

Sulfuric Acid @ 15¢/ton

Liquid Caustic @ 10¢/ton

\$4.39/ton paper

Total = $(158,400) (\$4.39) = \$695,376$

Finishing and shipping supplies (88¢/ton) = \$139,392

Other Variables:

Operating Labor	596,973
Payroll expenses operating labor	74,945
Coal	764,779
Machine Clothing	402,547
Water Treatment	87,617
Purchased Power	798,085
	\$2,724,926

Semi-Variable Conversion Cost (considered variable)

Repair Labor	257,720
Payroll Repair Labor	32,215
Repair Materials	331,346
Misc.	223,792
	\$845,073

Total Variable Conversion \$4,404,767

APPENDIX XXXXV (continued)

Fixed Conversion (excluding dep.)

Salaries Exempt	307,730
Salaries Non Exempt	95,238
Worker Expenses	250,000
Equipment Rental	94,782
Ins. + Prop. Tax at 2 1/4% of	
Investment (Arthur D. Little,	994,560
<u>op. cit.</u> , p.	
Total Fixed:	1,742,342

Fixed Conversion = 28% of total conversion incl. chem.
 = 32% excl. chemicals
 = 15.7% excl. chem. + prop. tax. + ins.

CGS, Normal Year = 14,616,303

CGS, 1st year = 12,924,066 (86% all variable costs)

7) Working Capital

6% Normal Sales + Land (\$1 MM) = 2,141,430

8) S, G, + A corporate @ 8.2% Normal Sales = 1,560,000

APPENDIX XXXXVI

PROGRAM GRANT

```

1 DIM S[50],O[50],C[50],N[50],G[50]
2 DIM P1[50],P2[50],F1[50],F2[50],K[50]
3 DIM H[50],E[50],W[50]
4 DIM T[50],M[50]
5 DIM B[50],D[50]
100 I1[0]=0
200 I1[1]=0
300 I1[2]=0
400 I2[0]=0
500 I2[1]=0
600 I2[2]=0
700 W2=0
800 S1=0
900 D1=0
1000 C1=0
1100 N1=0
1200 G1=0
1300 S2=0
1400 D2=0
1500 C2=0
1600 N2=0
1700 G2=0
1800 T=0
1900 L1=0
2000 L2=0
2100 L3=0
2200 D1=0
2300 D2=0
2310 T1=0
2320 D2=0
2400 S[3]=S1
2500 O[3]=O1
2600 C[3]=C1
2700 N[3]=N1
2800 G[3]=G1
2900 FOR J4= TO L3+2
3000 S[J]=S2
3100 O[J]=O2
3200 C[J]=C2
3300 G[J]=G2
3400 N[J]=N2
3500 NEXT J
3701 I1=I1[0]+I1[1]+I1[2]
3800 I2=I2[0]+I2[1]+I2[2]
3900 IF D1=2 THEN 4400
4000 FOR J=1 TO L1
4100 P1[J+2]=I1/L1
4200 NEXT J
4250 GO TO 5500
4300 P9=6
4400 FOR J=1 TO L1
4500 Z1=Z1+J
4600 NEXT J
4700 FOR J=1 TO L1
4800 F1[J]=O1/Z1
4900 Q1=Q1-1
5100 NEXT J
5200 FOR J=1 TO L1
5300 P1[J+2]=F1[J]+I1
5400 NEXT J
5500 IF D2=2 THEN 6000
5600 FOR J=1 TO L2
5700 P2[J+2]=I2/L2
5800 NEXT J
5900 GO TO 7200
6000 FOR J=1 TO L2
6100 Z2=Z2+J
6200 NEXT J
6300 P9=6
6400 Q2=L2
6500 FOR J=1 TO L2
6600 F2[J]=Q2/Z2
6700 Q2=Q2-1
6800 NEXT J
6900 FOR J=1 TO L2
7000 P2[J+2]=F2[J]+I2
7100 NEXT J
7200 W[L3+2]=W[2]
7300 FOR J=3 TO L3+2
7400 T[J]=S[J]+D[J]
7500 M[J]=T[J]-C[J]
7600 B[J]=M[J]-N[J]-P1[J]-P2[J]-G[J]
7700 D[J]=[1-T]+B[J]
7800 E[J]=D[J]+P1[J]+P2[J]
7900 NEXT J
8000 H[0]=-[I1[0]+I2[0]]+T1+I1[0]+T2+I2[0]
8100 H[1]=-[I1[1]+I2[1]]+T1+I1[1]+T2+I2[1]
8200 H[2]=-[I1[2]+I2[2]]+T1+I1[2]+T2+I2[2]
8300 H[L3+2]=W[L3+2]
8350 FOR J=0 TO L3+2
8400 K[J]=H[J]+E[J]
8600 NEXT J
8700 FOR X=0 TO L STEP .01
8800 P9=6
8900 FOR J=0 TO L3+2
9000 Y=K[J]/([1+X]^J)
9100 Y1=Y+Y1
9150 NEXT J
9200 IF Y1[0] THEN 9600
9250 Y1=0
9300 NEXT X
9400 X1=100
9500 GO TO 10400
9600 X=X-.01
9650 Y1=0
9700 FOR X1=X TO X+.01 STEP .001
9800 FOR J=0 TO L3+2
9900 Y=K[J]/([1+X1]^J)
10000 Y1=Y1+Y
10100 NEXT J
10200 IF Y1[0] THEN 19400
10250 Y1=9
10300 NEXT X1
10400 R4=100+X1
10500 PRINT "YEAR","PAT","CASHFLOW"
10700 PRINT 3,D[3],E[3]
10800 FOR J=4 TO L3+2
10900 IF D[J]=D[J-1] THEN 11100
11000 PRINT J,D[J],E[J]
11050 GO TO 11400
11100 IF E[J]=E[J-1] THEN 11400
11200 PRINT J,D[J],E[J]
11400 NEXT J
11500 PRINT "INTERNAL RATE OF RETURN = ";R4
11510 FOR J=3 TO L3+2
11520 E1=E[J]+E1
11530 IF E1/[I1+I2]] THEN 11550
11540 NEXT J
11550 R5=J
11560 PRINT "PAYBACK=";R5-2;"YEARS"
11570 FOR J=3 TO 7
11580 E3=E3+E[J]
11590 NEXT J
11595 E3=E3+E[J]
11600 R6=E3/[I1+I2+W[2]-5/2+[L1+I2/L2]]
11700 PRINT "FIVE YEAR RETURN ON NET ASSETS="
      "R6+20;" PERCENT"
99999 END

```

Source: Resource Planning Institute. Computer language is BASIC.

APPENDIX XXXXVI (continued)

"GRANT" INPUT FORM

100	I1(0)	= Plant Investment, First year
200	I1(1)	= Plant Investment, Second year
300	I1(2)	= Plant Investment, Third year
400	I2(0)	= Equipment Investment, First year
500	I2(1)	= Equipment Investment, Second year
600	I2(2)	= Equipment Investment, Third year
700	W(2)	= Working Capital
800	S1	= Sales in First year
900	O1	= Other Revenue in First Year
1000	C1	= Cost of Goods Sold in First year
1100	N1	= Non-Classified Cost in First year
1200	G1	= S,G, & A Cost in First Year
1300	S2	= Sales in Second and Subsequent Years
1400	O2	= Other Revenue in Second and Subsequent Years
1500	C2	= COGS in Second and Subsequent Years
1600	N2	= Non-Classified Cost in Second and Subsequent Years
1700	G2	= S,G, & A in Second and Subsequent Years
1800	T	= Tax Rate, Entered as Fraction (i.e. .52)
1900	L1	= Depreciable Life of Plant Investment
2000	L2	= Depreciable Life of Equipment Investment
2100	L3	= Life of Total Facility
2200	D1	= Depreciation Policy: If 1: Straight Line If 2: S-Y-D
2300	D2	= Depreciation Policy: If 1: Straight Line If 2: S-Y-D
2310	T1	= Plant Tax Credit
2320	T2	= Equipment Tax Credit

APPENDIX XXXXVII

CORRUGATED AND SOLID FIBER BOXES (SIC 2653) OPERATING RATIOS

	<u>1958</u>	<u>1967</u>
Production Workers as Percent of Total Employment	76	75
Cost of Materials per Dollar of Shipment (\$)	.64	.62
Cost of Materials and Payroll per Dollar of Shipment(\$)	.85	.84
Value Added per Production Man-Hour (\$)	5.40	7.41

Source: U.S. Bureau of the Census, 1967 Census of
Manufactures. Detailed statistics, p. 26C-5.

APPENDIX XXXXVIII

CORRUGATED AND SOLID FIBER BOXES (S.I.C. 2653)

Table V.1.3. SELECTED STATISTICS BY EMPLOYMENT SIZE OF ESTABLISHMENT 1967

	Establishments		Value Added by Manufacture		Capital Expenditure		End of Year Inventories	
	No.	Percent	\$ Millions	Percent	\$ Millions	Percent	\$ Millions	Percent
All Establishments	1071	100	1,130.0	100	127.7	100	258.0	100
1-4 employees	109	10.2	2.1	0.2	16.8	13.2	0.5	0.2
5-9 employees	54	5.0	5.3	0.5	2.1	1.6	0.9	0.3
10-19 employees	105	9.8	18.2	1.6	1.1	1.6	2.9	1.1
20-49 employees	250	23.4	84.9	7.5	20.0	15.7	13.4	5.2
50-99 employees	148	13.8	112.9	10.0	18.5	14.5	27.4	10.6
100-249 employees	333	31.1	628.1	55.6	46.0	36.0	152.6	59.2
250-499 employees	69	6.4	255.8	22.6	21.0	16.5	55.3	21.4
500-999 employees	3	0.3	22.7	2.0	1.2	0.9	5.1	2.0
1,000-2,499 employees	-	-	-	-	-	-	-	-
2,500 or more	-	-	-	-	-	-	-	-

Source: U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufacturers, Summary Statistics, Volume I, p. 2-7. Percentages calculated by author.

^bWithheld to avoid disclosing figures for individual companies.

APPENDIX XXXXIX

COMBINATION LINERBOARD AS A PERCENT OF TOTAL LINERBOARD, EXCLUDING GYPSUM

YEAR	PERCENT RECYCLED
1961	11.7
1962	10.0
1963	9.7
1964	9.3
1965	9.0
1966	8.0
1967	7.2
1968	5.7
1969	3.3
1970	2.8
1971	2.2

Source: American Paper Institute, Statistics of Paper 1972, Table II, and Bureau of the Census, "Current Industrial Reports", Series M. 26A (13) for 1968, 1969, 1970 and 1971 figures. Percentages calculated by author.

APPENDIX L

VIRGIN NATURAL LINERBOARD

- 1) Product 42 lb/1000 sq. feet Virgin Kraft Linerboard
- 2) Size 1000 tpd, 350,000 tpy
- 3) Investment = \$105,000 per daily ton (Arthur D. Little, Can Federal Procurement Practices Be Used to Reduce Solid Wastes, op. cit., p. 88, hereinafter referred to as Procurement Practices.)

Assume same time distribution of P, E expenditures as for Recycle Linerboard Mill

Thus:	Year	(-2)	(-1)	(0)
	P (\$000)	5,355	25,935	430.5
	E (\$000)	420	59,220	955.5

4) Sales

\$145/ton = \$3.05/MSF

Freight out = \$13/ton

[Procurement Practices, op. cit, estimates \$12, Midwest Box \$13, Big Box \$16]

Normal tons = 350,000 1st year = 301,000

Freight Out \$4,550,000

Net Sales Normal Year \$46,200,000

1st year:	Gross	43,645,000
	Freight	3,913,000
	Net	39,732,000

5) Fiber

\$45/output ton, based on actual, purchased fiber cost of Big Box

350,000 tpy \$45 = \$15,750,000 Normal year
= 13,545,000 1st year

6) Conversion Costs

Variable, including chemicals

Chemicals @ 65¢/ton (Procurement Practices, op. cit., p. 88) = 227,500

APPENDIX L (continued)

Direct Labor and Fringes = 2,587,200
[Assumed same as 800 tpd mill, Procurement Practices, op. cit.]
Supplies @ 3.75/ton (Ibid.)
Utilities @ 4.78/ton (Ibid.)
Maintenance labor and suppl. @ 9.60 (Ibid.)
= 3,360,000

Total Variable = \$9,160,200

Fixed (excl. dep.)

Factory O.H. (80% of Labor as per Procurement Practices, Ibid.) = \$2,069,760
Local Taxes and ins. @ 2 1/4% = 2,520,000
4,589,760

Total Conversion 13,749,960

Fixed Conv. = 33.4%, excl. chem. = 33.9%
= 18.8% excl. taxes and ins. + chem.

CGS Normal Year = 29,500,000

CGS 1st year = 26,012,500

7) W.C. @ 6.9% N. Normal Sales + \$1 MM land = 4,187,800

8) S,G, + A, corporate @ 8.2% Norm. Net. Sol. = 4,161,000

APPENDIX LI

PERCENTAGE RECYCLE CORRUGATING MEDIUM

Year	Percent Recycled
1961	21.5
1962	24.6
1963	24.7
1964	23.5
1965	22.7
1966	23.7
1967	21.9
1968	20.6
1969	19.8
1970	19.7
1971	19.1

Source: American Paper Institute, Statistics of Paper, 1972, Table II, and Bureau of the Census, "Current Industrial Reports," Series M 26A (13) for 1968-1971. Percentages calculated by author.

APPENDIX LII

COMBINATION (BOGUS) CORRUGATING MEDIUM

- 1) Product: 26 lb/MSF combination medium
- 2) Size: 300 tpd, 350 dpy, = 105,000 tpy
- 3) Investment:

Coverage of N.Y. and Chicago proposed new locations
for a Midwest Box Plant

Total P + E = \$18,908,000, plus land = (\$1 MM) plus W.C.

Time distribution the same as for recycle linerboard

YEAR	(-2)	(-1)	(0)
P \$	1,137,000	12,365,000	127,000
E \$	0	2,789,000	491,000

4) Sales

\$1.80/MSF = \$137.46/ton
Freight: assume city location \$8/ton
(midpoint of estimates)

Tons N.Y. = 105,000 1st year = 90,300

Gross Sales N.Y.	\$14,538,300
Fr.	840,000
Net Sales N.Y.	13,698,300
Gross Sales 1st yr	12,502,900
Fr.	722,400
Net Sales, 1st yr.	11,780,500

5) Fiber Input

Old Corrugated @ \$37 plus \$5 freight in
(midpoint of estimates)

Yield = 1.12

Fiber, N.Y. = 117,600 tons

Fiber, 1st yr. = 101,136 tons

Fiber cost, N.Y. = \$4,351,200

Fr. 588,000

Total Fib. and Fr., N.Y. = \$4,939,200

Fiber Cost, 1st yr. = \$3,742,000

Fr. 505,700

Total Fib. and Fr., 1st yr. = \$4,247,700

Table LII.1. 300 tpd Boqus Medium Mill
Plant and Equipment Capital Costs

<u>Capital Item (P or E)</u> ¹	<u>Cost (\$)</u>	<u>Year of Expenditure</u> ²
Site Preparation (P)	312,891	-2
Paper Mach. & Stock Prep (P & E)	8,053,371	-1
Finishing & Shipping (P & E)	253,115	0
Mill Water Supply (P)	328,364	-1
Waste Disposal (P & E)	837,524	-1
Waste Paper Facilities (P)	2,614,024	-1
Electric Power Plant (P)	1,038,135	-1
Non-Process Bldgs. (P)	298,872	-1
Total Direct	13,736,296	
Indirects and Constr. (P)	3,296,791	(-1)
Engineering (P)	824,198	(-2)
Contingency (P & E)	686,840	(-1)
Spare Parts (E)	274,500	(0)
Mobile Equip. (E)	75,000	(0)
Furniture (E)	15,000	(0)
Indirect	5,172,329	
TOTAL	18,908,625	

¹P or E designation by Resource Planning Associates Engineer.

²Year (1st operating year = (1) estimated by Resource Planning Associates Engineer.

APPENDIX LII (continued)

6) Conversion Costs (av. N.Y. and Chic., MWB Co.)

Variable, incl. chem

Chem @ \$.41/ton	= \$43,050
Other variable conv., inc. labor, repair, mat., supplies, fuel, power, wires, and felts @ 38.72	4,065,439
Total Var.	4,108,500
Total var., excl. chem.	4,065,400

Fixed, excl. dep.

Sal.	565,500
Misc.	104,300
Prop. tax + ins. @ 2 1/4%	447,900
Total fixed	1,117,700

Total Conversion, N.Y. = 5,226,200; 1st yr. = 4,651,000

Fixed = 21.4% incl. chem; 21.6% excl. chem.
= 14.1% excl. chem. + tax + ins.

Fiber + conv., N.Y. = 10,165,000
Fiber + Conv. 1st yr. = 8,899,000

7) W.C. @ 6% N.N.S. + \$1 MM land = 1,822,000

8) S, G, + A @ 8.2% N.S. = 1,192,000

APPENDIX LIII

VIRGIN CORRUGATING MEDIUM

- 1) Product: NSSC medium 26 lb/MSF
- 2) 650 tpd 350 dpy = 27,500 tpy
- 3) Investment (P + E) = \$53,000,000

plus land = 1,000,000
plus W.C.

Time distribution the same as for recycle linerboard

Year	(+2)	(-1)	(0)
Plant (\$000)	2,703	14,522	2,173
Equipment (\$000)	212	29,892	4,823

4) Sales

\$140/ton, freight \$13, as before noted

Normal tons: 227,500 1st year = 195,650

Gross Sales Normal Year : 31,850,000
Fr. 2,957,500

Net Sales N.Y. 28,892,500

Gross Sales 1st Year: 27,391,000
Fr. 2,543,450

Net Sales 1st yr. 24,847,550

5) Fiber

\$31/output ton [\$25-35 is range in MRI report], MRI, p. 93 says virgin fiber about \$11 less than recycled, so consistent. In practice, their furnish includes some prompt scrap.

Fiber cost, normal yr. = \$7,052,500
Fiber cost, 1st year = 6,064,741

6) Conversion Costs, from Midwest Box

APPENDIX LIII (continued)

Variable, incl. chem.

Chem. @ 1.30/ton
labor @ 8.27
fuel @ 9.91
Power @ 5.57
repair mat. @ 3.03
supplies @ 1.90
wires and felts @ 1.91

\$32.11/ton incl. chem. = 7,305,025
30.81/ton excl. chem. = 7,009,275

Fixed (excl. dep.)

sal. @ 2.88/ton	=	655,200
misc. @ 1.00/ton	=	227,500
prop. tax & ins. @ 2 1/4% Inv.	=	<u>1,215,000</u>

Total fixed 2,097,800

Total Conversion = 9,402,725 incl. chem.

Fixed = 22.3% incl. chem, 23.0% excl. chem.
= 11.2% excl. chem. + prop. taxes and ins.

CGS, N.Y. inc. tax + ins. = 16,455,225
CGS, 1st year = 14,444,762

7) W.C. @ 6.9% N.N.S. + \$1 MM land = 2,994,000

8) S,G, + A @ 8.2% N.N.S. = 2,612,000

APPENDIX LIV

COMBINATION FOLDING BOXBOARD AS PERCENT OF FOLDING BOXBOARD

YEAR	PERCENT RECYCLED
1961	83.4
1962	82.1
1963	81.1
1964	80.5
1965	81.8
1966	78.4
1967	66.2
1968	63.5
1969	NA
1970	66.1
1971	64.8

Source: American Paper Institute, Statistics of Paper
1972, Table II, and Bureau of Census,
"Current Industrial Reports", Series M.26A
(13) for 1968, 1969, 1970, 1971 figures.
Percentages calculated by author.

APPENDIX LV

FOLDING BOXES (SIC 2651) OPERATING RATIOS

	1958	1967
Production Workers as Percent of Total Employment	81	80
Cost of Materials per Dollar of Shipment (\$)	.56	.54
Cost of Materials and Labor per Dollar of Shipment (\$)	.82	.81
Value Added per Production Worker Man-hour (\$)	5.05	6.86

Source: U.S. Bureau of the Census. 1967 Survey of
Manufactures. Detailed statistics, P. 26C-6

APPENDIX LVI

FOLDING PAPERBOARD BOXES (S.I.C. 2651)

SELECTED STATISTICS BY EMPLOYMENT SIZE OF ESTABLISHMENT 1967

	Establishments		Value Added By Manufacture		Capital Expenditure		End of Year Inventories	
	No.	Percent	\$ Millions	Percent	\$ Millions	Percent	\$ Millions	Percent
All Establishments	560	100	563.2	100	42.2	100	172.7	100
1-4 employees	79	13.8	2.3	0.4	0.3	0.7	0.6	0.3
5-9 employees	34	5.9	2.7	0.5	0.1	0.3	0.6	0.3
10-19 employees	64	11.2	10.7	1.9	0.5	1.2	1.8	1.0
20-49 employees	140	24.6	47.2	8.4	2.7	6.4	10.1	5.9
50-99 employees	108	19.0	87.7	15.6	6.1	14.5	23.6	13.7
100-249 employees	100	17.5	189.4	33.6	16.1	38.2	58.0	33.6
250-499 employees	35	6.2	133.5	23.7	12.0	28.5	44.4	25.7
500-999 employees	9	1.6	89.8	15.9	4.3	10.2	33.7	19.5
1,000-2,499 employees	1	0.2	b	-	b	-	b	-
2,500 or more	-	-	-	-	-	-	-	-

Source: U.S. Department of Commerce, Bureau of the Census, 1967 Census of Manufacturers, Summary Statistics, Volume I, p. 2-7. Percentages calculated by author.
Withheld to avoid disclosing figures for individual companies.

APPENDIX LVII

COMBINATION FOLDING BOXBOARD .018 Caliper

- 1) Product: Recycle Boxboard, Clay Coated Newsback; 27.2 MSF/ton;
80B; Ultraformer
- 2) Size: 500 tpf 350 dpy = 175,000 tpy
- 3) Investment: \$37,500,000 + \$1 MM land and W.C.

Big Box 1970 estimate adjusted for Mackay Shields
estimates of cost increases in Kraft

Assumed Dist. as for Comb. Liner:

Year	(-2)	(-1)	(0)
P (\$000)	1,912	9,262	1,537
E (\$000)	150	21,150	3,412

4) Sales

\$7.70 MSF = \$209.44/ton
Freight @ \$8 (assume city location, midpoint of
estimates)
Tons: N.Y. = 175,000, 1st year: 150,500

Gross Sales, N.Y. = 36,652,000

Fr. = 1,400,000

Net Sales = 35,252,000

Gross Sales, 1st year = 31,521,000

Fr. = 1,204,000

Net Sales = 30,317,000

5) Fiber Input

Freight \$5
Yield: 90%

Top Liner : .2379 tons white ledger @ \$70 (Source:
Iannazzi, "Greater Use of Secondary Fiber
Through Dry Forming," op. cit.)

APPENDIX LVII (continued)

Filler:*

.6983 tons #1 News @ \$12

.1746 tons New Corr. Clipp. @ 62.50

1.11 tons @ \$35.62

Tons: N.Y.: 194,000; 1st year: 167,000

Fiber Cost, N.Y.:	\$6,910,000
Fr. 970,000	
Total Fiber Cost, N.Y.	7,880,000
Fiber Cost, 1st year	5,949,000
Fr. 835,000	
Total Fiber Cost	6,784,000

6) Conversion Cost

Variable, incl. chem.

chemicals @ \$18.90

*labor related @ \$13.67

*other @ \$29.38

Variable Conv.	\$43.04 exc. chemicals = \$7,534,000
	\$61.95 incl. chemicals = \$10,841,000

Fixed, excl. dep.

*O.H. @ 8.95	= 1,566,000
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Prop. tax and ins. @ 2 1/4 %	= <u>866,000</u>
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Total fixed	2,432,000
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Total Conversion: N.Y. = \$13,273,000; 1st year: 11,755

Fiber and Conv.: N.Y.	= 21,153,000
1st year	= 18,539,000

*Source: Assume split between Variable (excl. chem) and fixed (excl. prop. tax and ins.) is same as average of comb. linerboard and bogus medium (14.9% fixed). Within Variable, labor related are average of Bogus medium and recycled linerboard (37%). All non tax and insurance fixed expenses are assumed labor related. All labor related expenses are adjusted to 1973 prices.

APPENDIX LVII (continued)

7) W.C. @ 6% N.N.S. + land = 3,115,000

8) S,G, & A @ 8.2% N.S. = 3,005,000

APPENDIX LVIII

ARTHUR D. LITTLE DRY-FORMED COMBINATION BOXBOARD

1) Product: Clay Coated Newsback .018 caliper

Source: Fred Iannazzi, "Greater Uses of Secondary Fiber
Through Dry Forming Paper"

2) Size: 35 tpd, 330 dpy = 11,500 tpy

3) Investment: \$1,500,000 B,
464,000 P + land (8 times Iannazzi's
estimated rental = \$120,000)
Assume P in year -1, E in year 0

4) Sales

\$7.00/MSF = \$209.44/ton
Fr. = \$3 (Iannazzi)

Normal Tons: 11,500 1st year: 9,980

Gross Sales, N.Y. = \$2,408,600
Fr. 34,500

Net Sales, N.Y. 2,374,000

Gross Sales, 1st year. = \$2,090,200
Fr. 29,900

Net Sales 1st year = 2,060,000

5) Fiber Input

Freight in @ \$3/ton since near source (Iannazzi)

Yield = 95% (Iannazzi)

Top liner: .2242 tons white ledger @ \$69
plus \$3/ton

Filler:

.6632 ton #1 news @ \$12, plus \$3
.1653 tons New NSSC Corrugated Clippings
@ \$62.50, plus \$3

1.0527 tons @ 33.76 + \$3 freight

Fiber, N.Y. = 12,110 , 1st year = 10,400

Fiber Cost, N.Y. = 408,800

Fr. = 36,300

Total Fiber Cost, N.Y. = 445,000

APPENDIX LVIII (continued)

Fiber Cost, 1st year = 351,000
Fr. = 31,200
Total Fiber Cost, 1st year = 382,000

6) Conversion Costs

Variable Conv., incl. chemicals

Chem (clay + binders) @ \$20.9	\$240,500
Operating labor @ 12.40/ton	142,500
Utilities @ 7.70/ton	88,600
Supplies @ 5.00/ton	57,500

Var. Conf.	=	529,100 w/ chem.
		288,600 without chem.

Fixed Conversion, excl. dep.

Admin.	64,200
Local taxes and ins. @ 3%	58,920

Total Fixed	123,100
-------------	---------

Total Conversion: N.Y. = 652,000; 1st yr. = 578,000

Fiber + Conversion, N.Y. = 1,097,000

Fiber + Conversion, 1st yr. = 960,000

7) W.C. @ 6% N.N.S. = 142,000

8) S,G, + A @ 8.2% N.S. = 198,000

APPENDIX LIX

VIRGIN BOXBOARD .016 Caliper

- 1) Product: Virgin Boxboard 27.84 MSF/ton, SBS 80B (solid bleached sulphate, 80 brightness), .016 caliper
- 2) Size: 500 tpd, 350 dpy = 175,000 tpy
- 3) Investment: \$93,750,000 plus \$1 MM land

Big Box's 1970 est. const. cost times Kraft Mills' 25% increase from Mackay Shields, "Escalating Operating and Construction Costs...", op. cit.

Assumed Distribution same as for recycle linerboard

Year	(-2)	(-1)	(0)
P (\$000)	4,781	23,156	3,844
E (\$000)	375	52,875	8,531

4) Sales:

\$10.20/MSF = \$283.97/ton

Freight out = \$13/ton

[Procurement Practices, op. cit. p. 88.

estimated \$12, Midwest Box \$13, Big Box \$16]

Gross Sales Normal Year 49,694,750

Freight out @ \$13 2,275,000

Net Sales Normal Year 47,419,750

1st year:	Gross	42,737,490
	Fr.	1,956,500
	Net	40,780,990

5) Fiber

\$45/output ton including freight in

Source : Actual cost of purchased fiber 8/73 (Big Box)

Normal yr: (175,000) (\$45) = \$7,875,000 (3,937)

1st year 6,772,500 (3,386)

APPENDIX LIX (continued)

6) Conversion Costs

Variable, incl. chemicals

Chemicals: \$29.15/ton (Big Box)
Other variable:* labor related @ 12.67
other @ 27.24

Total var. \$39.91/ton, excl. chem = \$6,984,000
69.06/ton, incl. chem = 12,085,000

Fixed, excl. dep.

O.H. @ 8.17/ton = 1,430,000
Prop. tax and ins.
@ 2 1/4% = 2,132,000

Total fixed 3,562,000

Total Conversion; incl. chem N.Y. : 15,647,000; 1st yr:13,955,000
Fiber Plus Conversion: N.Y. = 23,522,000
1st yr. = 20,727,000

7) W.C. @ 6.9% N.N.S. = 3,272,000

8) S,G,+ A @ 8.2% N.S. = 4,075,000

* Source: From Big Box single conversion figure as follows:
split conversion into fixed and var., excluding
taxes, ins. and chemicals at the average of virgin
linerboard and medium = 15% fixed. Of the variable,
27% (from virgin medium) is assumed to be labor
related and adjusted upward appropriately from Big
Box's 1970 figures. The 15% fixed O.H. is adjusted
upward by same factor as labor (1.26 from Imperial).

APPENDIX LX

.022 CALIPER RECYCLE BOXBOARD, WHITE BACK

- 1) Product: .022 Caliper Combination Boxboard
Front: 80B, Back 70B; 23.25 MSF/ton, Ultraformer
- 2) Size: 500 tpd, 350 dpy = 175,000 tpy
- 3) Investment: 38,500,000 + W.C.
(Big Box 1970 estimate) (Mackay Shields estimate of cost increase for Kraft)

Assumed same distribution as for recycle linerboard

4) Sales

\$8.58/MSF = \$199.48/ton
Freight = \$8

Tons: N.Y.: 175,000; 1st year: 150,500

Gross Sales, N.Y.	= 34,909,000
Fr.	1,400,000
Net Sales, N.Y.	33,509,000
Gross Sales, 1st year	30,022,000
Fr.	1,204,000
Net Sales, 1st yr.	28,817,000

5) Fiber Input

Yield 90%, 1.11 input tons/output ton
Freight in = \$5.00

Fiber Furnish: $\left(\begin{array}{l} \text{Big Box's 1970 est.} \\ \text{adjusted for 90\%} \\ \text{yield} \end{array} \right) \left(\begin{array}{l} \text{1973 actual for} \\ \text{Newsback} \\ \hline \text{1970 est. for Newsback} \end{array} \right)$

$$= (39.55) \cdot \left(\frac{35.62}{25.61} \right) = \$55.00/\text{ton} + \text{trans.}$$

Tons: N.Y.: 194,000; 1st year: 167,000

APPENDIX LX (continued)

Fiber Cost, N.Y. =	10,670,000
Fr.	970,000
Total Fiber Cost, N.Y.	11,640,000
Fiber Cost, 1st yr.	9,185,000
Fr.	835,000
Total Fiber Cost	10,020,000

6) Conversion Costs

Variable, incl. chem.

Chemicals @ 20.61/ton
 *labor related @ 13.67
 *other @ 29.38

Variable Conv. \$43.05 excl. chem. = \$7,534,000
 63.66 incl. chem. 11,140,000

Fixed, excl. dep.

*O.H. @ 8.95 1,566,000
 Prop. tax + ins.
 @ 2 1/4% 866,000

Total Fixed 2,432,000

Total conversion: N.Y. 13,572,000; 1st yr.: 12,012,000

Fiber + Conversion:

N.Y. = \$25,212,000
 1st yr.: = 22,032,000

7) W.C. @ 6% N.N.S. = 2,011,000

8) S, G, + A @ 8.2% N.S. = 2,863,000

Source: Conversion figures are from same derivation from
 Big Box as .018 Newsback

APPENDIX LXI

VIRGIN BOXBOARD .022 Caliper

- 1) Product: Solid Bleached Sulphate . 022 caliper
boxboard; 80 brightness; 21.05 MSF/ton
- 2) Size: 500 tpd; 350 dpy; 175,000 tpy
- 3) Investment: 94,750,000 + W.C.; same distribution as
for recycle linerboard
- 4) Sales

\$10.98/MSF = \$231.13 ton
Freight out = \$13/ton as for UB .016
Normal tons: 175,000 1st yr: 150,500

Gross Sales N.Y.	\$40,447,700
Fr. Out	2,275,000
Net Sales	38,173,000
Gross Sales 1st year	34,785,000
Fr. Out	1,956,500
Net Sales, 1st year	32,829,000

5) Fiber

\$45/output ton, incl freight in
Source: actual purchase price of Big Box

Normal Year: \$7,875,000
1st year: 6,772,500

6) Conversion Costs

Variable, incl chem.

Chemicals @ 27.93/ton
labor related * @ 9.06
Other @ 24.51

Total Variable	\$33.57 excl. chem. = 5,875,000
	61.50 incl. chem. = 10,762,000

Fixed, excl. dep.

O.H.* @ 6.35	1,111,000
Prop. tax + ins.	
@ 2 1/4%	<u>2,132,000</u>

Total Fixed	3,243,000
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*Source: See virgin .016 caliper for explanation

APPENDIX LXI (continued)

Total Conversion, incl. chem: N.Y.: 14,005,000;
1st year; 12,498,000

Fiber plus Conversion: N.Y. = \$21,880,000
1st year = 19,270,000

7) W.C. @ 6.9% N.N.S. + \$1 MM land = \$3,634,000

8) S,G, + A @ 8.2% N.S. = \$3,317,000

APPENDIX LXII

LARGEST COMPANIES IN THE PAPER INDUSTRY

Rank in Fortune 1,000, 1972	Paper industry	Net sales, 1972
53	International Paper Company	2,093
74	Boise Cascade Corporation	1,710
126	The Mead Corporation	1,129
127	Crown Zellerbach Corporation	1,113
137	St. Regis Paper Company	1,013
139	Kimberly Clark Corporation	1,011
174	Scott Paper Company	814
229	Diamond International Corporation	604
230	Union Camp Corporation	602
243	Container Corporation of America	559
270	Westvaco	472
293	Bemis Company, Incorporated	428
299	Great Northern Nekoosa Corporation	410
307	Hammermill Paper Company	395
316	Potlatch Corporation	377
353	NVF Company	341
359	Southwest Forest Ind., Inc.	338
406	Hoerner Waldorf Corp.	281
432	Willamette Industries	257
445	Federal Paper Board Co., Inc.	248
473	Inland Container Corp.	222
483	Fibreboard Corp.	217
552	Dennison Manufacturing	177
567	Nashua Corporation	171
569	Maryland Cup Corporation	169
606	Sonoco Products Company	155
619	Consolidated Papers, Inc.	151
622	Longview Fibre Company	151
650	Alton Box Board Company	142
687	Stone Container Corporation	126
722	Bird and Son, Incorporated	116
770	Fort Howard Paper Company	103
810	Hudson Pulp and Paper Corporation	95
841	Southland Paper Mills, Inc.	90
868	U.S. Envelope	84
870	Papercraft	84
888	Chesapeake Corporation of Virginia	83
949	MacAndrews and Forbes Company	74
976	Chase Bag Company	70
980	Consolidated Packaging Corporation	70
<u>Other Companies with Large Paper and Paperboard Production</u>		
20	The Proctor and Gamble Co.	3,514
49	Continental Can Company, Inc.	2,193
57	American Can Company	2,016
58	Georgia Pacific Corporation	1,929
62	Champion International	1,872
77	Weyerhaeuser Company	1,676
81	Owens-Illinois, Inc.	1,636
114	Olin Corporation	1,251
507	Ludlow Corporation	202

Source: Fortune Magazine May and June 1973 as recorded by the Economics Department, American Paper Institute, July 5, 1973.